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For Release IMMEDIATE

Press Kit

Project Meteosat

RELEASE NO: 77-230

Contents

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IMMEDIATE

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RELEASE NO: 77-230

NASA TO LAUNCH METEOSAT IN WORLDWIDE WEATHER STUDY

The European Space Agency's (ESA's) Meteosat is scheduled to be launched no earlier than Nov. 17 from Cape Canaveral, Fla., by NASA's Delta 2914 rocket. The weather satellite will become a part of a worldwide meteorological program employing as many as five geostationary satellites. Launch window is from 8:35 to 9:05 p.m. EST. The satellite's final Earth synchronous orbital position will be latitude 0, longitude 0, placing it over the western coast of South Africa.

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Meteosat will be one of the first practical applications of European space research and technology. Eight of ESA's 10 member countries are participating: Belgium, Denmark, France, Germany, Italy, Sweden, Switzerland and the United Kingdom.

The five spacecraft comprising the worldwide program will be placed at equal distances around the globe and will transmit cloud cover images to ground stations for processing and relay to users. Meteorological data collected from platforms, buoys and low polar orbiting satellites will also be collected. This system will be an important element of the Global Weather Experiment (GWE), a part of the Global Atmospheric Research Program (GARP).

Additionally, the U.S. and the Soviet Union plan to launch two satellites each into polar orbit. The mission of these satellites is to:

- Collect and disseminate observation data on cloud formations and Earth surface temperatures.
- Collect and disseminate meteorological observations data from ships, buoys and unmanned observatories.
- Observe solar protons by space environment monitor.

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In addition to those countries participating in the satellite portion of GWE, approximately 145 countries also will make contributions to the worldwide weather effort by taking daily surface and atmospheric measurements in their respective areas.

All of the data will be sent to Central Data Centers in Moscow and Washington, D.C. Current planning calls for the program to be ready for the first intensive observation period by December of 1978.

The global system of precisely placed satellites in geostationary orbit will extend the presently limited amount of meteorological data European scientists receive from U.S. spacecraft designed to provide information for one or two day forecasts of weather conditions in the United States. Since climatic conditions in one part of the world can affect the weather many thousands of kilometers away, the continuous observation of all the Earth's surface and cloud cover by the global system will produce for Europe, or any other region, accurate weather forecasts for more than just a couple of days.

The potential value of advanced, accurate weather forecasts to agriculture, forestry, fishing, transportation, tourist and construction industries is of tremendous value.

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Severe storm warnings or other weather extremes as well as favorable forecasts for leisure and work can affect the lives of people throughout the world.

Meteosat observes the Earth and its cloud cover in both the visible light and infrared regions. A high resolution radiometer achieves a definition of 2.5 kilometers (1.6 miles) on the ground in daylight; 5 km (3.1 mi.) in the infrared. Images are composed of 2,500 lines in the infrared, 5,000 lines in the visible light channel. A line-by-line scan picture is taken every 30 minutes. Line scanning is achieved by the satellite's rotation at approximate 100 rpm. Line-to-line shifting is obtained by tipping the telescope.

Unprocessed images received directly from Meteosat are of sufficient quality to be of immediate use. For more precise definition compatible with international Automatic Picture Transmission (APT) and Weather Facsimile (WEFAX) standards, the raw picture is processed by computer on the ground and sent back to the satellite for retransmission to weather stations. WEFAX transmissions can be sent for the complete coverage with lower resolution, or with high resolution for a limited zone. Two transmission channels are devoted to WEFAX.

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Images will be utilized in a variety of ways. Infrared images will help determine Earth surface and cloud temperatures with a precision of 1 degee Celsius (33.8 Fahrenheit). Cloud height can be deduced from these temperatures. Wind velocity, especially in the tropics, may be determined with 3 meters-per-second precision from the observed movement of small clouds.

Data will be collected from the interrogation of Earth stations, buoys at sea and weather balloons. Meteosat has a data retransmission capability. It will send to processing sites data collected by satellites in low polar orbit such as those taking vertical soundings of atmospheric temperatures obtained by a multispectral infrared radiometer.

This system's flexibility makes data acquired by Meteosat available, through its sister spacecraft in the global network, to meteorologists, oceanographers, hydrologists and other Earth scientists thus contributing significant improvements in weather forecasting.

Although Meteosat's most obvious, even spectacular, potential is that of saving human lives and limiting property damage by early warning of hurricanes or severe storms, its contributions will also be felt in agriculture, fishing and all industries where weather and climate are related.

Meteosat is 2.10 meters (7 feet) in diameter, 3.195 m (10.4 ft.) in height excluding the apogee boost motor (ABM) and weighs 697 kilograms (1,535 pounds) including the 345 kg (760 lb.) ABM and fittings.

Data Acquisition, Telecommand and Tracking Station (DATTS) will be the telecommunication terminal for the main S-band up/down links with the satellite. Located at Odenwald (near Darmstadt) Germany, DATTS will be linked to three facilities of the European Space Operations Center (ESOC) at Darmstadt. These are:

MOCC (Meteosat Operations Control Center) which controls the entire system and coordination of operations.

DRCC (Data Referencing and Conditioning Center) for general data handling and processing.

MIEC (Meteorological Information Extraction Center) for reception and display of full resolution digital pictures or WEFAX data.

NASA's Space Tracking and Data Network (STDN) has full telemetry and command support responsibility for the Meteosat mission from pre-launch activities through a portion of the drift-orbit phase, until the spacecraft comes into view of the dedicated ESA ground station.

At that time, ESA assumes full mission responsibility and NASA STDN support terminates. The Ascension Island STDN will, however, provide emergency backup command support.

STDN station activities are coordinated between Goddard's Network Operations Control Center, Greenbelt, Md., and ESOC Darmstadt, in accordance with previously established NASA and ESA interface agreements.

The prime STDN Meteosat support stations are Orroral Valley, Australia, and Guam (Pacific) for the first apogee and all subsequent odd-numbered apogees. Santiago, Chile, and Rosman, N.C., sites are the prime sites for the second apogee and all subsequent even-numbered apogees.

During the 24 hour period following the apogee motor firing, continuous tracking is provided by the in-view STDN sites. Continuous telemetry and command support from one station is provided from apogee motor firing plus three hours until acquisition by an ESA ground station. Support thereafter is limited to occasional coverage by one station (on demand).

The Cannes Establishment of Aerospatiale is prime contractor for the development of Meteosat, heading the Cosmos Consortium which includes:

AEROSPATIALE (Societe' Nationale Industrielle Aerospatiale, France)

CASA (Constructiones Aeronautics S.A., Spain)

ETCA (Etudes Techniques et Constructions Aeronautiques, Belgium)

MBB (Messerschmitt-Bolkow-Blohm, Germany)

MSDS (Marconi Space and Defence Systems, Ltd.. United Kingdom)

SAT (Societe Anonyme de Telecommunications, France)

SELENIA Spa (Italy)

Siemens AG (Germany)

Additionally, the Cannes Establishment of Aerospatiale is responsible for project management, systems studies, integration and testing.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)

METEOSAT LAUNCH PROFILE

The first two stages of the Delta 2914 place the spacecraft into a low altitude parking orbit 185 km (115 mi.) near the first equatorial crossing. Spinup to 100 rpm, followed by injection into a transfer orbit using the Delta third stage, occurs after a few minutes in parking orbit.

If spacecraft operation is normal Meteosat will be boosted into synchronous orbit when the apogee motor is fired at the first apogee (approximately 27 hours after liftoff). For a nominal transfer orbit, the subsatellite longitude at this time is 91 degrees E.

Following burnout of the Delta third stage and spacecraft separation, Meteosat will be in transfer orbit. Transfer orbit is a highly elliptical inclined orbit with a perigee altitude of 185 km (115 mi.) and an apogee of 1,200 km (745 mi.) above synchronous altitude. When the spacecraft motor is fired at apogee in a precise orientation, the orbit will be circularized and the launch inclination removed.

During transfer orbit the spacecraft with apogee motor attached is unstable about its principal (spin) axis. To minimize nutation buildup about this spin axis, an active nutation control system is activated when the spacecraft separates from the Delta third stage. Precise control of thruster firings by this active nutation control system maintains spacecraft stability about the spin axis.

Prior to apogee motor firing, the spacecraft spin axis must be reoriented to the correct attitude. This reorientation will be started as soon as possible after determination of injection attitude and subsequent apogee motor firing attitude. The apogee motor firing attitude will be aligned to inject the spacecraft into near-synchronous drift orbit for arrival on station in less than two weeks.

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DELTA LAUNCH VEHICLE

First Stage

The first stage is a McDonnell Douglas modified Thor booster incorporating nine Castor II strap-on Thiokol solid fuel rocket motors. The booster is powered by a Rocketdyne engine using liquid oxygen and liquid hydrocarbon propellants. The main engine is gimbal-mounted to provide pitch and yaw control from liftoff to main engine cutoff (MECO).

Second Stage

The second stage is powered by a TRW liquid-fuel, pressure-fed engine that also is gimbal-mounted to provide pitch and yaw control during coast and after second stage cutoffs. Two fixed nozzles, fed by the propellant tank, helium pressurization system, provide retrothrust after third stage separation. Fifty-six minutes after spacecraft separation, the second stage will be reignited for a 12 second burn. Data on this burn will be collected for studies related to future Delta missions.

Third Stage

The third stage is the TE-364-4 spin-stabilized, solid propellant Thiokol motor. It is secured in the spin table mounted to the second stage. The firing of eight solid propellant rockets fixed to the spin table accomplishes spin-up of the third stage spacecraft assembly.

Injection Into Synchronous Orbit

The Delta vehicle will inject Meteosat into a transfer orbit having an apogee of 36,999 km (22,990 mi.), a perigee of 185 km (115 mi.) and an inclination of 27.5 degrees. NASA's Spaceflight Tracking and Data Network will provide telemetry, tracking and ranging support until the spacecraft is placed in its final synchronous orbit at 0 degrees E. longitude. Command, control, tracking and data analysis are the responsibilities of the European Space Operations Center (ESOC).

STRAIGHT EIGHT DELTA FACTS AND FIGURES

Height: 35.4 m (116 ft.) including shroud

Maximum Diameter: 2.4 m (8 ft.) without attached solids

Liftoff Weight: 131,895 kg (293,100 lb.)

Liftoff Thrust: 1,765,315 newtons (396,700 lb.) including strap-on solids

First Stage

(Liquid only) consists of an extended long-tank Thor produced by McDonnell Douglas. The RS-27 engines are produced by the Rocketdyne Division of Rockwell International. The stage has the following characteristics:

Diameter: 2.4 m (8 ft.)

Height: 21.3 m (70 ft.)

Propellants: RJ-1 kerosene as the fuel and liquid oxygen (LOX) as the oxidizer

Thrust: 912,000 N (205,000 lb.)

Burning Time: About 3.48 minutes

Weight: About 84,600 kg (186,000 lb.) excluding strap-on solids

Strap-on solids consist of nine solid-propellant rockets produced by the Thiokol Chemical Corp. with the following features:

Diameter: 0.8 m (31 in.)

Height: 7 m (23.5 ft.)

Total Weight: 40,300 kg (88,650 lb.) for nine
4,475 kg (9,850 lb.) for each

Thrust: 2,083,000 N (468,000 lb.) for nine
231,400 N (52,000 lb.) for each

Burning Time: 38 seconds

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Second Stage

Produced by McDonnell Douglas Astronautics Co., using a TRW TR-201 rocket engine; major contractors for the vehicle inertial guidance system located on the second stage are Hamilton Standard, Teledyne and Delco.

Propellants: Liquid, consists of Aerozene 50 for the fuel and nitrogen tetroxide (N_2O_4) for the oxidizer.

Diameter: 1.5 m (5 ft.) plus 2.4 m (8 ft.) attached ring

Height: 6.4 m (21 ft.)

Weight: 6,118 kg (13,596 lb.)

Thrust: About 42,943 N (9,650 lb.)

Total Burning Time: 335 seconds

Third Stage

Thiokol Chemical Co. TE-364-4 motor.

Propellant: Solid

Height: 1.4 m (4.5 ft.)

Diameter: 1 m (3 ft.)

Weight: 1,152 kg (2,560 lb.)

Thrust: 61,855 N (13,900 lb.)

Burning Time: 44 seconds

LAUNCH OPERATIONS

The Kennedy Space Center's Expendable Vehicles Directorate plays a key role in the preparation and launch of the thrust-augmented Delta rocket carrying the Meteosat spacecraft.

Delta 136 will be launched from Pad A, northernmost of the two launch pads at Complex 17, Cape Canaveral Air Force Station.

The Delta first stage and interstage were erected on Pad A Oct. 3. Nine Castor II solid strap-on rocket motors were mounted in place around the base of the first stage Oct. 4-5. The second stage was mated with the first stage Oct. 6.

One of the nine Castor II solid motors was removed Oct. 19 and taken to the Redstone Arsenal in Huntsville, Ala., for a test firing Oct. 20. The successful test of that solid motor and another motor which would have been flown on Delta 137 with a Japanese communications satellite in December cleared the way for the successful launch of Delta 135 with International Sun Earth Explorers 1 and 2 by Kennedy Center Oct. 22. It was replaced Oct. 28.

The Meteosat spacecraft was received at Kennedy Center Sept. 19. After its initial checkout in Hangar AE, it was moved to the Spin Test Facility Oct. 31. Movement of the spacecraft/third stage assembly to the pad for mating with Delta 136 is scheduled for Nov. 10.

Based upon a Nov. 17 launch date, the payload fairing which protects the spacecraft on its flight through the atmosphere is to be put in place Nov. 15.

TYPICAL LAUNCH SEQUENCE FOR METEOSAT/DELTA 136

Event	Time	Altitude Nautical Miles	Velocity Ft./Sec.
Liftoff	0 sec.	0	0
Six Solid Motor Burnout	38 sec.	19,156 ft.	2,218
Three Solid Motor Ignition	39 sec.	22,054 ft.	2,219
Three Solid Motor Burnout	1 min. 17 sec.	69,337 ft.	3,795
Nine Solid Motor Jettison	1 min. 27 sec.	13.8 mi.	4,089
Main Engine Cutoff (MECO)	3 min. 48 sec.	50.2	17,610
First/Second Stage Separation	3 min. 56 sec.	53.2	17,635
Second Stage Ignition	4 min. 1 sec.	55.0	17,615
Fairing Jettison	4 min. 42 sec.	67.8	18,245
Second Stage Cutoff (SECO-1)	8 min. 58 sec.	86.1	25,802
Restart Second Stage	21 min. 46 sec.	95.7	25,726
Second Stage Cutoff (SECO-II)	21 min. 53 sec.	95.9	26,002
Third Stage Spinup	22 min. 43 sec.	97.7	25,990
Second/Third Stage Separation	22 min. 45 sec.	97.8	25,989
Third Stage Ignition	23 min. 26 sec.	99.6	25,977
Third Stage Burnout	24 min. 10 sec.	102.9	33,693
Third Stage/Spacecraft Separation	25 min. 23 sec.	123	33,582

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DELTA 136/METEOSAT TEAM

European Space Agency

Roy Gibson	Director General
Dr. Ernst Trendelenberg	Director of Scientific and Meteorological Programs
Dr. Dieter Lennertz	Meteorological Program Manager
David Leverington	Spacecraft Manager
Claude Honbault	Ground Segment Manager

NASA Headquarters

John F. Yardley	Associate Administrator for Space Flight
Joseph B. Mahon	Director of Expendable Launch Vehicle Programs
Peter T. Eaton	Manager, Delta Programs

Goddard Space Flight Center

Dr. Robert S. Cooper	Director
Robert E. Smylie	Deputy Director
Robert Lindley	Director of Projects
Robert Baumann	Associate Director Space Transportation Systems
David W. Grimes	Delta Project Manager
William R. Russell	Deputy Delta Project Manager, Technical
John Langmead	Deputy Project Manager, Resources
Robert Goss	Chief, Mission Analysis and Integration Branch, Delta Project Office

Goddard Center (cont'd.)

Frank J. Lawrence	Delta Mission Integration Manager
Richard H. Scalafford	Mission Operations and Network Support Manager
Ray Mazur	Mission Support

Kennedy Space Center

Lee R. Scherer	Director
Gerald D. Griffin	Deputy Director
Dr. Walter J. Kapryan	Director, Space Vehicles Operations
George F. Page	Director, Expendable Vehicles
W. C. Thacker	Chief, Delta Operations Division
Bert L. Grenville	Chief, Delta Operations Branch
Gayle Hager	Spacecraft Coordinator

CONTRACTORS

McDonnell Douglas Astronautics Co. Huntington Beach, Calif.	Delta launch vehicle

Meteosat Prime Contractors

Aerospatiale, France

MATRA

ETCA, Belgium

MBB, Germany

MSDS, United Kingdom

Selenia, Italy

Siemens, Germany

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NASA
National Aeronautics and
Space Administration

Astronauts
Fact Sheet

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COVER

Astronaut L. Gordon Cooper, his silver suit flickering in the mid-Pacific sun, steps out of his spacecraft "Faith 7" into the deck of the recovery ship after 22 orbits in space, May 15 and 16, 1963. This painting by artist Mitchell Jamieson is exhibited in the National Air and Space Museum, Washington, D.C.

NASA Photo: 65-H-253

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ASTRONAUT FACT SHEET

Of 73 pilots and scientists selected as astronauts since April 1959, 26 are on flight status at the National Aeronautics and Space Administration's Lyndon B. Johnson Space Center, Houston, Tex., and one other, now on other assignment, is available as flight crewman. The number of pilot-astronauts is 17 and 10 are scientist-astronauts.

Seven groups of astronauts have been selected. In Group 1 were the seven Mercury astronauts selected in April 1959. Nine test pilots, Group 2, were selected in September 1962. In Group 3 were 14 pilot-astronauts selected in October 1963. Group 4, the first six scientist-astronauts, was selected in June 1965. In April 1966, 19 pilot-astronauts were selected as Group 5. Group 6, 11 scientist-astronauts, was selected in August 1967. Seven Air Force Manned Orbital Laboratory pilots joined the NASA pilot-astronaut program in August 1969, as Group 7.

ALPHABETICAL LIST OF THE 73 ASTRONAUTS SELECTED

NAME	ASTRONAUT STATUS	GROUP NUMBER
Aldrin, Edwin E., Jr.	Retired	3
Allen, Joseph P.	Flight	6
Anders, William A.	Retired	3
Armstrong, Neil A.	Retired	2
Bassett, Charles A.	Deceased	3
Bean, Alan L.	Flight	3
Bobko, Karol J.	Flight	7
Borman, Frank	Retired	2
Brand, Vance D.	Flight	5
Bull, John S.	Resigned	5
Carpenter, M. Scott	Retired	1
Carr, Gerald P.	Retired	5
Cernan, Eugene A.	Retired	3
Chaffee, Roger B.	Deceased	3
Chapman, Philip K.	Resigned	6
Collins, Michael	Retired	3
Conrad, Charles, Jr.	Retired	2
Cooper, L. Gordon	Retired	1
Crippen, Robert L.	Flight	7
Cunningham, Walter	Retired	3
Duke, Charles M., Jr.	Retired	5
Eisele, Donn F.	Retired	3
England, Anthony W.	Resigned	6
Engle, Joe H.	Flight	5
Evans, Ronald E.	Retired	5
Freeman, Theodore C.	Deceased	3
Fullerton, Charles G.	Flight	7
Garriott, Owen K.	Flight	4
Gibson, Edward G.	Flight	4
Givens, Edward G.	Deceased	5
Glenn, John H.	Retired	1
Gordon, Richard F., Jr.	Retired	3
Graveline, Duane E.	Resigned	4
Grissom, Virgil I.	Deceased	1
Haise, Fred W., Jr.	Flight	5
Hartsfield, Henry W.	Flight	7
Henize, Karl G.	Flight	6
Holmquest, Donald L.	Resigned	6
Irwin, James B.	Retired	5

NAME	ASTRONAUT STATUS	GROUP NUMBER
Kerwin, Joseph P.	Flight	4
Lenoir, William B.	Flight	6
Lind, Don L.	Flight	5
Llewellyn, John A.	Resigned	6
Lousma, Jack R.	Flight	5
Lovell, James A., Jr.	Retired	2
Mattingly, Thomas K. II	Flight	5
McCandless, Bruce II	Flight	5
McDivitt, James A.	Retired	2
Michel, F. Curtis	Resigned	4
Mitchell, Edgar D.	Retired	5
Musgrave, F. Story	Flight	6
O'Leary, Brian T.	Resigned	6
Overmyer, Robert F.	Flight	7
Parker, Robert A.	Flight	6
Peterson, Donald H.	Flight	7
Pogue, William R.	Leave of Absence	5
Roosa, Stuart A.	Retired	5
Schirra, Walter M., Jr.	Retired	1
Schmitt, Harrison H.	Resigned	4
Schweickart, Russell L.	Resigned	3
Scott, David R.	Retired	3
See, Elliott J.	Deceased	2
Shepard, Alan B., Jr.	Retired	1
Slayton, Donald K.	Flight	1
Stafford, Thomas P.	Retired	2
Swigert, John L., Jr.	Resigned	5
Thornton, William E.	Flight	6
Truly, Richard H.	Flight	7
Weitz, Paul J.	Flight	5
White, Edward H. II	Deceased	2
Williams, Clifton C.	Deceased	3
Worden, Alfred M.	Retired	5
Young, John W.	Flight	2

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Group 1, Project Mercury Astronauts Selected April 1959

Flight Status

Donald K. Slayton, Civilian, Manager for Approach and Landing Test, Space Shuttle Program Office, JSC.

No Longer on Flight Status

M. Scott Carpenter, Commander, USN (Ret.), joined U.S. Navy Sealab program 1967. Retired from Navy July 1969 and in private business, Los Angeles, Calif.

L. Gordon Cooper, Colonel, USAF (Ret.), retired July 1970; is Vice President for Research and Development, WED Enterprises, Glendale, Calif.

John H. Glenn, Jr., Colonel, USMC (Ret.), resigned in 1964. Elected U.S. Senator (D-Ohio), November 1974.

Walter M. Schirra, Jr., Captain, USN (Ret.), retired in July 1969. He is Director of Technology Purchase, Johns-Manville Corp., Denver, Colo.

Alan B. Shepard, Jr., Rear Admiral, USN (Ret.), retired from the U.S. Navy and NASA Aug. 1, 1974. He is President of Windward Co., Deer Park, Tex.

Deceased

Virgil I. (Gus) Grissom, Lieutenant Colonel, USAF, died in Apollo spacecraft fire at Kennedy Space Center, Jan. 27, 1967.

Group 2, Test Pilot Astronauts Selected September 1962

Flight Status

John W. Young, Captain, USN (Ret.), Chief, Astronaut Office, Johnson Space Center.

Group 2 (cont'd.)

No Longer on Flight Status

Neil A. Armstrong, Professor of Engineering, University of Cincinnati, effective October 1971. Previously was Deputy Associate Administrator, Aeronautics, NASA Headquarters Office of Advanced Research and Technology, 1970.

Frank Borman, Colonel, USAF (Ret.), President and Chief Operations Officer, Eastern Airlines, Miami, Fla. Retired from NASA and Air Force in July 1970.

Charles Conrad, Jr., Captain, USN (Ret.), retired Feb. 1, 1974. He is Vice President, Marketing, McDonnell Douglas Corp., with offices in Denver, Colo.

James A. McDivitt, Brig. General, USAF (Ret.), President, Pullman Standard Co., Chicago, Ill. He was manager, Apollo Spacecraft Program, NASA Lyndon B. Johnson Space Center, September 1969-1972. He retired from NASA and Air Force Sept. 1, 1972.

James A. Lovell, Jr., Captain, USN (Ret.), is President of Fisk Telephone Systems, Inc., Houston. He served as Deputy Director of Science and Applications, JSC, May 1971-March 1973 when he retired from NASA and the Navy.

Thomas P. Stafford, Major General, USAF. Returned to active Air Force status as Commander, Air Force Flight Test Center, Edwards Air Force Base, Calif., effective Nov. 1, 1975.

Deceased

Elliot M. See, Jr., died in a T-38 jet crash Feb. 28, 1966, Lambert Municipal Airport, St. Louis.

Edward H. White, II, Lieutenant Colonel, USAF, died in Apollo spacecraft fire at Kennedy Space Center Jan. 27, 1967.

Group 3, Pilot Astronauts Selected October 1963

Flight Status

Alan L. Bean, Captain, USN (Ret.).

No Longer on Flight Status

William A. Anders, Formerly U.S. Ambassador to Norway. Formerly Chairman, Nuclear Regulatory Commission. Was Commissioner of the Atomic Energy Commission, August 1973. He served as Executive Secretary, National Aeronautics and Space Council, September 1969-1973. General Manager, Nuclear Energy Products Division with General Electric Co., San Jose, Calif.

Edwin E. Aldrin, Jr., Colonel, USAF (Ret.). He resigned from NASA July 1971 and served as Commander of the Air Force Aerospace Research Pilots School, Edwards, Calif., until he retired from active duty about March 1, 1972. President of Research and Engineering Consultants, Inc., Los Angeles, Calif.

Eugene A. Cernan, Captain, USN (Ret.), retired from the Navy and NASA July 1, 1976. He is Executive Vice President, International, Coral Petroleum Co., Houston.

Michael Collins, became Assistant Secretary of State for Public Affairs in January 1970. Since February 1971 is Director, National Air and Space Museum, Smithsonian Institution, Washington, D.C.

Walter Cunningham, resigned Aug. 1, 1971. He is now Senior Vice President 3D/International, Houston.

Donn F. Eisele, Colonel, USAF (Ret.). Resigned from NASA and retired from the Air Force, July 1972 and joined the Peace Corps. Served as technical assistant for Manned Space Flight, NASA Langley Research Center, Hampton, Va., 1970-1972. Eastern Manager, Marion Power Shovel Co., Williamsburg, Va.

Group 3 (cont'd.)

Richard F. Gordon, Jr., Captain, USN (Ret.), retired from the Navy and NASA Jan. 1, 1972; John W. Mecom Co., Houston.

Russell L. Schweickart, transferred to NASA Headquarters, Washington, D.C., May 1, 1974. Now Assistant for Payload Operations, Office of Planning and Program Integration. Detailed to Governor Brown of California.

David R. Scott, Colonel, USAF (Ret.), appointed Director, NASA Hugh L. Dryden Flight Research Center, Edwards, Calif., April 1975, after serving as the Center Deputy Director since August 1973. He was a special assistant for mission operations, Apollo Spacecraft Program Office, JSC from July 1972 until August 1973. Resigned from NASA Oct. 30, 1977, to enter private business in Los Angeles.

Deceased

Charles A. Bassett II, Major, USAF, died in T-38 jet crash with Elliot See, Feb. 28, 1966, at St. Louis.

Roger B. Chaffee, Lieutenant Commander, USN, died in Apollo spacecraft fire, Kennedy Space Center, Jan. 27, 1967.

Theodore C. Freeman, Captain, USAF, died in T-38 crash Ellington AFB, Houston, Oct. 31, 1964.

Clifton C. Williams, Jr., Major, USMC, died in T-38 crash near Tallahassee, Fla., Oct. 5, 1967.

Group 4, Scientist Astronauts Selected June 1965

Flight Status

Owen K. Garriott, Ph.D. (Electrical Engineering), Assistant Director for Space Sciences, Space and Life Sciences Directorate, Johnson Space Center.

Edward G. Gibson, Ph.D. (Engineering and Physics).

Joseph P. Kerwin, Captain, USN, M.D. (Medicine).

Group 4 (cont'd.)

No Longer on Flight Status

Duane E. Graveline, M.D. (Medicine), resigned for personal reasons in August 1965.

Frank Curtis Michel, Ph.D. (Physics), resigned August 1969 to return to scientific research at Rice University, Houston.

Harrison H. Schmitt, Ph.D. (Geology), resigned from NASA August 1975. Assigned as Special Assistant to NASA Administrator for Energy Research and Development, February 1974; appointed NASA Assistant Administrator for Energy Programs, NASA Headquarters, Washington, D.C., May 1974. Elected U.S. Senator (R-New Mexico), November 1976.

Group 5, Pilot Astronauts Selected April 1966

Flight Status

Vance D. Brand, Civilian.

Joe H. Engle, Colonel, USAF.

Fred W. Haise, Jr., Civilian.

Don L. Lind, Civilian, Ph.D. (Physics).

Jack R. Lousma, Lieutenant Colonel, USMC.

Thomas K. Mattingly, II, Commander, USN.

Bruce McCandless, II, Commander, USN.

Paul J. Weitz, Captain, USN.

No Longer on Flight Status

John S. Bull, Lieutenant Commander, USN (Ret.), withdrew because of pulmonary disease July 1968. Employed in Guidance and Navigation Branch, NASA Ames Research Center, Moffett Field, Calif.

Gerald P. Carr, Colonel, USMC (Ret.), resigned effective June 25, 1977, to join the Houston consulting engineering firm of Bovay Engineers, Inc., as corporate manager for business development.

Group 5 (cont'd.)

Charles M. Duke, Jr., resigned as Colonel, USAF, effective Jan. 1, 1976, to establish Orbit Corp., a business in San Antonio, Tex.

Ronald E. Evans, Captain, USN (Ret.), resigned effective March 15, 1977, to become executive vice president of Western American Energy Corp. and director of WES-PAC Energy, the coal producing concern of WAEC, in Scottsdale, Ariz.

James B. Irwin, Colonel, USAF (Ret.), retired from USAF and NASA Aug. 1, 1972; is Chairman of the Board of Christian evangelical organization, High Flight Foundation, Colorado Springs, Colo.

Edgar D. Mitchell, Captain, USN (Ret.), retired from Navy and NASA Oct. 1, 1972. He is President, Edgar D. Mitchell and Associates, Inc., Palm Beach, Fla.

William R. Pogue, Colonel, USAF (Ret.). On leave of absence from NASA.

Stuart A. Roosa, Colonel, USAF (Ret.), retired from Air Force and NASA Feb. 1, 1976. He is Vice President, International Affairs, U.S. Industries, Inc., and resides in Athens, Greece.

John L. Swigert, Jr., appointed Staff Executive Director, Committee on Science and Astronautics, House of Representatives in April 1973. Resigned from NASA and has announced candidacy for U.S. Senate from Colorado.

Alfred M. Worden, Colonel, USAF (Ret.), assigned to NASA Ames Research Center, Mountain View, Calif., September 1972 as Chief, Systems Studies Division. He has been a vice president of High Flight Foundation, Colorado Springs, Colo., since Sept. 5, 1975. Resides in Palm Beach, Fla.

Deceased

Edward G. Givens, Jr., Major, USAF, died in an automobile accident near Houston, June 6, 1967.

Group 6, Scientist Astronauts Selected August 1967

(All Civilian)

Flight Status

Joseph P. Allen, Ph.D. (Physics), appointed NASA Assistant Administrator for Legislative Affairs August 1975. Available for Space Shuttle flight.

Karl G. Henize, Ph.D. (Astronomy)

William B. Lenoir, Ph.D. (Electrical Engineering)

Story Musgrave, M.D., Ph.D. (Medicine and Physiology)

Robert A. Parker, Ph.D. (Astronomy)

William E. Thornton, M.D. (Medicine)

No Longer on Flight Status

Philip K. Chapman, Sc.D. (Aeronautics and Astronautics), resigned in July 1972. Was Principal Research Scientist with AVCO Everett Research Laboratories, Everett, Mass., and served as a senior research associate at the MIT Measurement Systems Laboratory, Cambridge, Mass. Now with Arthur D. Little Co. in Cambridge, Mass.

Anthony W. England, Ph.D. (Geology and Physics), resigned in August 1972 to accept position with U.S. Geological Survey.

John A. Llewellyn, Ph.D. (Chemistry), resigned for personal reasons, August 1968.

Brian T. O'Leary, Ph.D. (Astronomy), resigned for personal reasons, April 1968.

Donald L. Holmquest, M.D. and Ph.D. (Medicine and Physiology), took leave of absence May 1971 to hold position of assistant professor of Radiology and Physiology, Baylor College of Medicine, Houston. Later resigned from NASA to become Associate Dean of Medicine, Texas A&M University, College Station, Tex. He is now at the Navasota Medical Center, Navasota, Tex.

-more-

Group 7, Pilot Astronauts (Former Air Force Manned Orbiting Laboratory Pilots who entered NASA program in August 1969)

Flight Status

Karol J. Bobko, Colonel, USAF

Robert L. Crippen, Commander, USN

Charles G. Fullerton, Lieutenant Colonel, USAF

Henry W. Hartsfield, Jr., Colonel, USAF

Robert F. Overmyer, Lieutenant Colonel, USMC

Donald H. Peterson, Colonel, USAF

Richard H. Truly, Commander, USN

-more-

MERCURY FLIGHT CREWS

(See pp. 24-26 for dates and significant facts on missions)

Mercury Redstone 3

Flight Pilot:

Alan B. Shepard, Jr.

Backup Pilot:

John H. Glenn

Mercury Redstone 4

Flight Pilot:

Virgil I. Grissom

Backup Pilot:

John H. Glenn

Mercury Atlas 6

Flight Pilot:

John H. Glenn

Backup Pilot:

M. Scott Carpenter

Mercury Atlas 7

Flight Pilot:

M. Scott Carpenter

Backup Pilot:

Walter M. Schirra, Jr.

Mercury Atlas 8

Flight Pilot:

Walter M. Schirra, Jr.

Backup Pilot:

L. Gordon Cooper

Mercury Atlas 9

Flight Pilot:

L. Gordon Cooper

Backup Pilot:

Alan B. Shepard, Jr.

GEMINI FLIGHT CREWS

Gemini 3

Flight Crew:

Commander, Virgil I. Grissom
Pilot, John W. Young

Backup Crew:

Commander, Walter M. Schirra, Jr.
Pilot, Thomas P. Stafford

Gemini 4

Flight Crew:

Commander, James A. McDivitt
Pilot, Edward H. White, II

Backup Crew:

Commander, Frank Borman
Pilot, James A. Lovell, Jr.

-more-

Gemini 5

Flight Crew:

Commander, L. Gordon Cooper
Pilot, Charles Conrad, Jr.

Backup Crew:

Commander, Neil A. Armstrong
Pilot, Elliott J. See

Gemini 6

Flight Crew:

Commander, Walter M. Schirra, Jr.
Pilot, Thomas P. Stafford

Backup Crew:

Commander, Virgil I. Grissom
Pilot, John W. Young

Gemini 7

Flight Crew:

Commander, Frank Borman
Pilot, James A. Lovell, Jr.

Backup Crew:

Commander, Edward H. White, II
Pilot, Michael Collins

Gemini 8

Flight Crew:

Commander, Neil A. Armstrong
Pilot, David R. Scott

Backup Crew:

Commander, Charles Conrad, Jr.
Pilot, Richard F. Gordon, Jr.

Gemini 9

Flight Crew:

Commander, Thomas P. Stafford
Pilot, Eugene A. Cernan

Backup Crew:

Commander, James A. Lovell, Jr.
Pilot, Edwin E. Aldrin, Jr.

Gemini 10

Flight Crew:

Commander, John W. Young
Pilot, Michael Collins

Backup Crew:

Commander, Alan L. Bean
Pilot, Clifton C. Williams

Gemini 11

Flight Crew:

Commander, Charles Conrad, Jr.
Pilot, Richard F. Gordon, Jr.

Backup Crew:

Commander, Neil A. Armstrong
Pilot, William A. Anders

Gemini 12

Flight Crew:

Commander, James A. Lovell, Jr.
Pilot, Edwin E. Aldrin, Jr.

Backup Crew:

Commander, L. Gordon Cooper
Pilot, Eugene A. Cernan

APOLLO FLIGHT CREWS

Apollo-Saturn 204

Prime Crew: (Died in spacecraft fire Jan. 27, 1967, approximately 1 month before mission was scheduled)

Commander, Virgil I. Grissom
Command Module Pilot, Edward H. White, II
Lunar Module Pilot, Roger B. Chaffee

Backup Crew:

Commander, Walter M. Schirra, Jr.
Command Module Pilot, Donn F. Eisele
Lunar Module Pilot, Walter Cunningham

Apollo 7

Flight Crew:

Commander, Walter M. Schirra, Jr.
CM Pilot, Donn F. Eisele
LM Pilot, Walter Cunningham

Backup Crew:

Commander, Thomas P. Stafford
CM Pilot, John W. Young
LM Pilot, Eugene A. Cernan

Apollo 8

Flight Crew:

Commander, Frank Borman
CM Pilot, James A. Lovell, Jr.
LM Pilot, William A. Anders

Backup Crew:

Commander, Neil A. Armstrong
CM Pilot, Edwin E. Aldrin, Jr.
LM Pilot, Fred W. Haise, Jr.

-more-

Apollo 9

Flight Crew:

Commander, James A. McDivitt
CM Pilot, David R. Scott
LM Pilot, Russell L. Schweickart

Backup Crew:

Commander, Charles Conrad, Jr.
CM Pilot, Richard F. Gordon, Jr.
LM Pilot, Alan L. Bean

Apollo 10

Flight Crew:

Commander, Thomas P. Stafford
CM Pilot, John W. Young
LM Pilot, Eugene A. Cernan

Backup Crew:

Commander, L. Gordon Cooper
CM Pilot, Donn F. Eisele
LM Pilot, Edgar D. Mitchell

Apollo 11

Flight Crew:

Commander, Neil A. Armstrong
CM Pilot, Michael Collins
LM Pilot, Edwin E. Aldrin, Jr.

Backup Crew:

Commander, James A. Lovell, Jr.
CM Pilot, William A. Anders
LM Pilot, Fred W. Haise, Jr.

Apollo 12

Flight Crew:

Commander, Charles Conrad, Jr.
CM Pilot, Richard F. Gordon, Jr.
LM Pilot, Alan L. Bean

Backup Crew:

Commander, David R. Scott
CM Pilot, Alfred M. Worden
LM Pilot, James B. Irwin

Apollo 13

Flight Crew:

Commander, James A. Lovell, Jr.
CM Pilot, John L. Swigert, Jr.*
LM Pilot, Fred W. Haise, Jr.

Backup Crew:

Commander, John W. Young
CM Pilot, John L. Swigert, Jr.
LM Pilot, Charles M. Duke, Jr.

Apollo 14

Flight Crew:

Commander, Alan B. Shepard, Jr.
CM Pilot, Stuart A. Roosa
LM Pilot, Edgar D. Mitchell

Backup Crew:

Commander, Eugene A. Cernan
CM Pilot, Ronald E. Evans
LM Pilot, Joe H. Engle

*Substituted for Thomas K. Mattingly, II, who had been exposed to, but did not contract, measles.

Apollo 15

Flight Crew:

Commander, David R. Scott
CM Pilot, Alfred M. Worden
LM Pilot, James B. Irwin

Backup Crew:

Commander, Richard F. Gordon, Jr.
CM Pilot, Vance D. Brand
LM Pilot, Harrison H. Schmitt

Apollo 16

Flight Crew:

Commander, John W. Young
CM Pilot, Thomas K. Mattingly, II
LM Pilot, Charles M. Duke, Jr.

Backup Crew:

Commander, Fred W. Haise, Jr.
CM Pilot, Stuart A. Roosa
LM Pilot, Edgar D. Mitchell

Apollo 17

Flight Crew:

Commander, Eugene A. Cernan
CM Pilot, Ronald E. Evans
LM Pilot, Harrison H. Schmitt

Backup Crew:

Commander, John W. Young
CM Pilot, Stuart A. Roosa
LM Pilot, Charles M. Duke, Jr.

SKYLAB CREWS

First Manned Mission

Flight Crew:

Commander, Charles Conrad, Jr.
Science Pilot, Dr. Joseph P. Kerwin
Pilot, Paul J. Weitz

Backup Crew:

Commander, Russell L. Schweickart
Science Pilot, Dr. Story Musgrave
Pilot, Bruce McCandless, II

Second Manned Mission

Flight Crew:

Commander, Alan L. Bean
Science Pilot, Dr. Owen K. Garriott
Pilot, Jack R. Lousma

Backup Crew:

Commander, Vance D. Brand
Science Pilot, Dr. Don L. Lind
Pilot, Dr. William E. Lenoir

Third Manned Mission

Flight Crew:

Commander, Gerald P. Carr
Science Pilot, Dr. Edward G. Gibson
Pilot, William R. Pogue

Backup Crew:

(Same backup crew as second manned mission)

APOLLO SOYUZ TEST PROJECT CREW

Prime Crew:

Commander, Thomas P. Stafford
Command Module Pilot, Vance D. Brand
Docking Module Pilot, Donald K. Slayton

Backup Crew:

Commander, Alan L. Bean
Command Module Pilot, Ronald E. Evans
Docking Module Pilot, Jack R. Lousma

Support Crew:

Richard H. Truly
Robert F. Overmyer
Robert L. Crippen
Karol J. Bobko

SHUTTLE ORBITER APPROACH AND LANDING TEST FLIGHTS

Crews:

Commander Fred W. Haise, Jr.
Pilot Charles G. Fullerton

(Haise and Fullerton were the crew for Captive Flights 1 and 3, and Free Flights 1, 3 and 5.)

Commander Joe H. Engle
Pilot Richard H. Truly

(Engle and Truly were the crew for Captive Flight 2, and Free Flights 2 and 4.)

ASTRONAUTS WHO HAVE FLOWN IN SPACE (43)

One Flight (26)

William A. Anders	Apollo 8
Vance D. Brand	Apollo Soyuz
M. Scott Carpenter	Mercury 7
Gerald P. Carr	Skylab 4
Walter Cunningham	Apollo 7
Charles M. Duke, Jr.	Apollo 16
Donn F. Eisele	Apollo 7
Ronald Evans	Apollo 17
Owen K. Garriott	Skylab 3
Edward G. Gibson	Skylab 4
John H. Glenn	Mercury 6
Fred W. Haise, Jr.	Apollo 13
James B. Irwin	Apollo 15
Joseph P. Kerwin	Skylab 2
Jack R. Lousma	Skylab 3
Thomas K. Mattingly, II	Apollo 16
Edgar D. Mitchell	Apollo 14
William R. Pogue	Skylab 4
Stuart A. Roosa	Apollo 14
Harrison H. Schmitt	Apollo 17
Russell L. Schweickart	Apollo 9
Donald K. Slayton	Apollo Soyuz
John L. Swigert, Jr.	Apollo 13
Paul J. Weitz	Skylab 2
Edward H. White, II	Gemini 4
Alfred M. Worden	Apollo 15

Two Flights (10)

Edwin E. Aldrin, Jr.	Gemini 12, Apollo 11
Neil A. Armstrong	Gemini 8, Apollo 11
Alan L. Bean	Apollo 12, Skylab 3
Frank Borman	Gemini 7, Apollo 8
Michael Collins	Gemini 10, Apollo 11
L. Gordon Cooper	Mercury 9, Gemini 5
Richard F. Gordon, Jr.	Gemini 11, Apollo 12
Virgil I. Grissom	Mercury 4, Gemini 3
James A. McDivitt	Gemini 4, Apollo 9
Alan B. Shepard, Jr.	Mercury 3, Apollo 14

Three Flights (3)

Eugene A. Cernan	Gemini 9, Apollo 10, Apollo 17
Walter M. Schirra	Mercury 8, Gemini 6, Apollo 7
David R. Scott	Gemini 8, Apollo 9, Apollo 15

Four Flights (4)

Charles Conrad, Jr.	Gemini 5, Gemini 11, Apollo 12, Skylab 2
James A. Lovell, Jr.	Gemini 7, Gemini 12, Apollo 8, Apollo 13
John W. Young	Gemini 3, Gemini 10, Apollo 10, Apollo 16
Thomas P. Stafford	Gemini 6, Gemini 9, Apollo 10, Apollo Soyuz

-more-

Mission	Crew	Date	Duration hr:min:sec	Remarks
Mercury-Redstone 3	Shepard	May 5, 1961	00:15:22	Suborbital flight – first American in space. USS Champlain, Atlantic recovery (A). Spacecraft call sign Freedom 7.
Mercury-Redstone 4	Grissom	July 21, 1961	00:15:37	Also suborbital; successful flight but spacecraft sank, astronaut rescued. USS Randolph (A). Liberty Bell 7.
Mercury-Atlas 6	Glenn	Feb. 20, 1962	04:55:23	Three-orbit flight; first American in orbit; retropack retained when erroneous signal indicated heat shield possibly loose; capsule landed 40 miles uprange. USS Noa, (A). Friendship 7.
Mercury-Atlas 7	Carpenter	May 24, 1962	04:56:05	Also three-orbit mission; yaw error at manual retrofire caused 250-mile landing overshoot. USS Pierce (A). Aurora 7.
Mercury-Atlas 8	Schirra	Oct. 3, 1962	09:13:11	Six-orbit flight; capsule landed 4-1/2 miles from recovery ship USS Kearsarge, Pacific (P). Sigma 7.
Mercury-Atlas 9	Cooper	May 15 and 16 1963	34:19:49	Twenty-two orbits to evaluate effects on man of 1 day in space; landed 4-1/2 miles from USS Kearsarge (P). Faith 7.
Gemini-Titan III	Grissom, Young	March 23, 1965	04:53:00	Three-orbit demonstration of the spacecraft; maneuver over Texas on first pass changed orbital path of a manned spacecraft for first time; landed about 50 miles uprange. USS Intrepid (A). Molly Brown (only Gemini named).
Gemini-Titan IV	McDivitt, White	June 3 to 7, 1965	97:56:11	Four-day flight with White first American to walk in space in 20-minute extravehicular activity (hatch open 36 minutes); after 62 revolutions of Earth, landed 50 miles uprange from USS Wasp (A).
Gemini-Titan V	Cooper, Conrad	Aug. 21 to 29, 1965	190:55:14	First use of fuel cells for electric power; evaluated guidance and navigation system for future rendezvous missions; incorrect navigation coordinates from ground control resulted in landing 90 miles short; 120 revolutions. USS Lake Champlain (A).
Gemini-Titan VII	Borman, Lovell	Dec. 4 to 18, 1965	330:35:31	Longest-duration Gemini flight; provided rendezvous target for Gemini VI-A; crew flew portions of mission in shirtsleeves for first time; 206 revolutions; landed 6.4 miles from target. USS Wasp (A).
Gemini-Titan VI-A	Schirra, Stafford	Dec. 15 and 16, 1965	25:51:24	Rescheduled to rendezvous with Gemini VII after original target Agena failed to orbit; VI-A launch postponed 3 days when launch vehicle engines automatically shut down 1.2 seconds after ignition; completed first space rendezvous; after 16 revolutions, landed within 7 miles of target to initiate series of pinpoint landings by Gemini spacecraft. USS Wasp (A).
Gemini-Titan VIII	Armstrong, Scott	March 16, 1966	10:41:26	First docking of one space vehicle with another; about 27 minutes after docking, Gemini-Agena combination began to yaw and roll at increasing rates; emergency procedures included undocking, deactivation of malfunctioning spacecraft control system, activation of reentry control system; mission was terminated and, midway through 7th revolution, spacecraft landed 1.1 miles from planned landing point in secondary recovery area in western Pacific; destroyer USS Mason picked up crew 3 hours later.
Gemini-Titan IX-A	Stafford, Cernan	June 3 to 6, 1966	72:21:00	Rescheduled to rendezvous and dock with augmented target docking adapter after original target Agena failed to orbit; ATDA shroud did not completely separate, making docking impossible; three different types of rendezvous were completed; Cernan carried out 2 hours 7 minutes of EVA; 44 revolutions; 0.38 miles from target. USS Wasp (A).

Gemini-Titan X	Young, Collins	July 18 to 21, 1966	70:46:39	First use of Agena target vehicle's propulsion systems; spacecraft also rendezvoused with Gemini VIII target vehicle; Collins had 49 minutes of EVA standing in hatch, 39-minute EVA to retrieve experiment from Agena VIII; 43 revs; 3.4 miles, USS Guadalcanal (A).
Gemini-Titan XI	Conrad, Gordon	Sept. 12 to 15, 1966	71:17:08	Gemini record altitude (739.2 miles) reached using Agena propulsion after first-revolution rendezvous and docking; Gordon fastened Agena-anchored tether to Gemini docking bar, and spacecraft later made two revolutions of Earth in tethered configuration; Gordon 33-minute EVA and 2-hour 5-minute standup EVA; 44 revs; 1.5 miles, USS Guam (A).
Gemini-Titan XII	Lovell, Aldrin	Nov. 11 to 15, 1966	94:34:31	Final Gemini flight; Aldrin logged 2-hour 29-minute standup EVA, 55-minute standup EVA, and 2-hour 6-minute EVA for Gemini record total of 5 hours 30 minutes of extravehicular activity; 59 revs, 2.6 miles, USS Wasp (A).
Apollo-Saturn 7	Schirra, Eisele, Cunningham	Oct. 11 to 22, 1968	260:09:03	First manned flight of Apollo spacecraft command-service module only, 163 revolutions; USS Essex (A) — all Apollo spacecraft splashed down within 10 miles of predicted landing point.
Apollo-Saturn 8	Borman, Lovell, Anders	Dec. 21 to 27, 1968	147:00:42	First flight to the Moon (command-service module only); views of lunar surface televised to Earth; 10 revolutions of the Moon; USS Yorktown (P).
Apollo-Saturn 9	McDivitt, Scott, Schweickart	March 3 to 13, 1969	241:00:54	First manned flight of lunar module; spacecraft call signs for communications identification when undocked: CSM "Gumdrop" and LM "Spider"; Schweikart 37-minute EVA from LM; 151 revs; USS Guadalcanal (A).
Apollo-Saturn 10	Stafford, Young, Cernan	May 18 to 26, 1969	192:03:23	First lunar module orbit of Moon; call signs Charlie Brown and Snoopy; 31 revs of Moon (4 revs by undocked LM); USS Princeton (P).
Apollo-Saturn 11	Armstrong, Collins, Aldrin	July 16 to 24, 1969	195:18:35	First lunar landing; call signs Columbia and Eagle; lunar stay time 21 hours 36 minutes 21 seconds, Armstrong and Aldrin EVA (hatch open to hatch close) 2 hours 31 minutes 40 seconds, lunar surface samples 48.5 pounds; 30 revs; USS Hornet (P).
Apollo-Saturn 12	Conrad, Gordon, Bean	Nov. 14 to 24, 1969	244:36:25	Yankee Clipper and Intrepid; stay time 31 hours 31 minutes, Conrad and Bean EVAs 3 hours 56 minutes and 3 hours 49 minutes, lunar samples 74.7 pounds plus parts from Surveyor 3 unmanned spacecraft; 45 revs; USS Hornet (P).
Apollo-Saturn 13	Lovell, Swigert, Haise	Apr. 11 to 17, 1970	142:54:41	Odyssey and Aquarius; mission aborted after service module oxygen tank ruptured; using lunar module oxygen and power until just before reentry, crew returned safely to Earth; USS Iwo Jima (P).
Apollo-Saturn 14	Shepard, Roosa, Mitchell	Jan 31 to Feb 9, 1971	216:01:57	Kitty Hawk and Antares; stay time 33:31, Shepard and Mitchell EVAs 4:48 and 4:35, samples 96 pounds; 34 revs; USS New Orleans (P).
Apollo-Saturn 15	Scott, Worden Irwin	July 26 to Aug 7, 1971	295:11:53	Endeavour and Falcon; first use of lunar roving vehicle; stay time 66:55; Scott standup EVA 33 minutes, Scott and Irwin EVAs 6:33, 7:12 and 4:50, Worden trans-Earth EVA 38 minutes, samples 170 pounds; 74 revs; USS Okinawa (P).
Apollo-Saturn 16	Young, Mattingly Duke	April 16 to April 27, 1972	265:51:05	Casper and Orion; stay time 71:02; Young and Duke EVAs 7:11, 7:23 and 5:40, Mattingly trans-Earth EVA 1:24, samples 213 pounds; 64 revs; USS Ticonderoga (P).
Apollo-Saturn 17	Cernan, Evans, Schmitt	Dec. 7 to Dec. 19, 1972	301:51:59	America and Challenger; stay time 75:00; Cernan and Schmitt EVAs 7:12, 7:37 and 7:15, Evans trans-Earth EVA 1:06, samples 243 pounds; 75 revs; USS Ticonderoga (P). First night launch, Dec. 6, in Central, Mountain and Pacific time zones.

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MISSION	CREW	DATE	DURATION	DESCRIPTION
Skylab 2 (first manned mission)	Conrad Kerwin Weitz	May 25 to June 22, 1973	672:49:49 (28 days)	First U. S. manned orbiting space station mission; crew deployed solar shield; released stuck solar panel. These repair activities permitted manned operations of the Orbital Workshop after meteoroid shield was damaged and torn off during boost. Data obtained on 46 of 55 experiments. Crew performed 3 space walks totaling 5 hours, 41 minutes; USS Ticonderoga.
Skylab 3	Bean Garriott Lousma	July 28 to Sept. 25, 1973	1427:09:04 (59 days)	Crew performed systems and operational tests, deployed new solar shield, replaced rate gyros. Crew substantially exceeded pre-mission plans for scientific activities. Performed three space walks totaling 13 hours, 44 minutes; USS New Orleans.
Skylab 4	Carr Gibson Pogue	Nov. 16, 1973 to Feb. 8, 1974	2017:15:32 (84 days)	Final Skylab manned visit; longest flight of men in space. Crew replenished coolant supplies, repaired antenna, made observations of Comet Kohoutek. Crew performed four space walks totaling 22 hours, 21 minutes. Set record for space walk duration -- 7 hours, 1 minute; USS New Orleans.
Apollo Soyuz Test Project	Stafford Brand Slayton	July 15-24, 1975	217:28:24 (9 days)	First U.S.-U.S.S.R. joint manned mission; accomplished spacecraft rendezvous and docking; crew transfer; docking and undocking; interaction of control centers and interaction of spacecraft crews; USS New Orleans.

-more-

ASTRONAUTS COMPARATIVE FLIGHT TIME

ASTRONAUT	FLIGHTS	HRS., MINS.
Carr	1	2017:15
Gibson	1	2017:15
Pogue	1	2017:15
*Bean (4th)	2	1671:45
Garriott	1	1427:09
Lousma	1	1427:09
*Conrad (3rd)	4	1179:38
Lovell	4	715:05
Kerwin	1	672:49
Weitz	1	672:49
*Cernan (11th)	3	566:15
*Scott (7th)	3	546:54
*Young (9th)	4	533:33
Stafford	4	507:43
Borman	2	477:36
McDivitt	2	338:57
Gordon	2	315:53
Evans	1	301:51
*Schmitt (12th)	1	301:51
Schirra	3	295:13
*Irwin (8th)	1	295:11
Worden	1	295:11
*Aldrin (2nd)	2	289:53
Collins	2	266:05
Mattingly	1	265:51
*Duke (10th)	1	265:51
Eisele	1	260:09
Cunningham	1	260:09
Schweickart	1	241:01
Cooper	2	225:15
Brand	1	217:28
Slayton	1	217:28
*Shepard (5th)	2	216:17
*Mitchell (6th)	1	216:01
Roosa	1	216:01
*Armstrong (1st)	2	206:00
Anders	1	147:00
Haise	1	142:54
Swigert	1	142:54
White	1	97:56
Grissom	2	5:08
Carpenter	1	4:56
Glenn	1	4:55

*Walked on the lunar surface (in order of walk)

EXTRAVEHICULAR ACTIVITY (EVA) RECORD

Mission	Launch Date	In-Flight Astronaut	In-Flight Hrs/Min	Lunar Exploration Astronaut	Lunar Exploration Hrs/Min	Lunar-Stay Time Hrs/Min	Site
Gemini 4	6/3/65	White	00:23				
Gemini 9	6/3/66	Cernan	2:10				
Gemini 10	7/18/66	Collins	1:27				
Gemini 11	9/12/66	Gordon	2:44				
Gemini 12	11/11/66	Aldrin	5:30				
Apollo 9	3/3/69	Schweickart	00:46				
Apollo 11	7/16/69			Armstrong Aldrin	2:40 2:15	21:36	Sea of Tranquility
Apollo 12	11/14/69			Conrad Bean	7:45	31:31	Ocean of Storms
Apollo 14	1/31/71			Shepard Mitchell	9:17	33:30	Fra Mauro
Apollo 15	7/26/71	Worden	00:38	Scott Irwin	18:35	66:54	Hadley Apennine
Apollo 16	4/16/72	Mattingly	1:13	Young Duke	20:15	71:14	Descartes
Apollo 17	12/7/72	Evans	1:06	Cernan Schmitt	22:04	74:59	Taurus-Littrow
Skylab SL 1&2 1st Manned Visit	5/25/73	Conrad Kerwin Weitz	6:34 3:58 2:11				
Skylab SL 3 2nd Manned Visit	7/28/73	Bean Garriott Lousma	2:41 13:42 11:01				
Skylab SL 4 3rd Manned Visit	11/16/73	Carr Gibson Pogue	15:48 15:17 13:31				

-end-

NASA News

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RELEASE NO: 77-232

NINTH GROUP OF ASTRONAUT CANDIDATES AT HOUSTON NOV. 7-11

The ninth group of Space Shuttle astronaut applicants is scheduled to be at NASA's Johnson Space Center, Houston, Tex., Nov. 7-11 for a week of physical examinations and individual interviews.

This group includes 21 mission specialist applicants and two pilot applicants. Eleven of the applicants are military with representatives from each of the four services. Two of the applicants are women bring the total number of women applicants to be interviewed thus far to 20.

-more-

Mailed:
November 7, 1977

Of the 8,079 who applied for the Space Shuttle astronaut program, approximately 200 are being brought to Johnson Center in groups of 20 or more for further screening. With this group, 183 applicants have been selected to come to Johnson Center for further screening. Of the above, 79 are pilots and 104 are mission specialist applicants.

As many as 20 astronaut candidates will be selected in each category -- pilot and mission specialist. Those selected will be notified in December and will report to Johnson Center at a later date for a two-year training and evaluation period. The candidates will become astronauts after satisfactory completion of the two-year period.

The names, age, degrees and/or military rank, place of birth, high school (HS) and current duty station or place of employment of the individuals in this ninth group are:

Franklin S. Achille, 29, Lieutenant, USN
Doylestown, Pa. HS: Los Altos, Calif.
Naval Air Test Center, Patuxent River, Md.

David W. Anderson, 29, Lieutenant, USN
Lincoln, Ill. HS: Princeton, Ind.
Naval Air Test Center, Patuxent River, Md.

Guion S. Bluford, Jr., 34, Major, USAF
Philadelphia, Pa. HS: Philadelphia, Pa.
Wright Patterson AFB, Dayton, Ohio

-more-

Joseph C. Boudreaux III, 30, Lieutenant, USN
New Orleans, La. HS: Severna Park, Md.
Cruiser Destroyer Group 5, FPO San Francisco, Calif.

David R. Dougherty, 32, Ph.D.
Enid, Okla. HS: Enid, Okla.
Louisiana State University, Baton Rouge, La.

Thomas E. Edwards, 35, Captain, USA, Ph.D.
Starkville, Miss. HS: Starkville, Miss.
U.S. Army Air Mobility Research and Development Lab.
NASA/Langley Research Center, Hampton, Va.

John M. Fabian, 38, Major, USAF, Ph.D.
Goosecreek, Tex. HS: Pullman, Wash.
U.S. Air Force Academy, Colorado Springs, Colo.

William F. Fisher, 31, M.D.
Dallas, Tex. HS: N. Syracuse, N.Y.
Los Angeles, Calif.

Stuart J. Fitrell, 38, Commander, USN (pilot)
Cleveland, Ohio HS: East Cleveland, Ohio
Commanding Officer, Attack Squadron 66,
NAS, Cecil Field, Fla.

Dale A. Gardner, 28, Lieutenant, USN
Fairmont, Minn. HS: Savanna, Ill.
NAS, Pt. Mugu, Calif.

Robert L. Golden, 37, Ph.D.
Alameda, Calif. HS: Alameda, Calif.
NASA/Johnson Space Center, Houston, Tex.

Terry J. Hart, 31
Pittsburgh, Pa. HS: Pittsburgh, Pa.
Bell Telephone Laboratories, Whippany, N.J.

Barbara J. Holden, 32, Ph.D.
Los Angeles, Calif. HS: Lincoln, Neb.
Naval Weapons Center, China Lake, Calif.

Gary R. Jackman, 32, Ph.D.
Waterbury, Conn. HS: Cheshire, Conn.
University of Florida, Gainesville, Fla.

Lawrence W. Lay, 33, D.O.
Kansas City, Mo. HS: Kansas City, Mo.
Flint Osteopathic Hospital, Flint, Mich.

-more-

Samuel F. Logan, 30, M.D.
Los Angeles, Calif. HS: Woodland Hills, Calif.
University of California, Los Angeles Medical
School, Los Angeles, Calif.

Gregory B. McKenna, 28, Ph.D.
Pittsburgh, Pa. HS: Pittsburgh, Pa.
National Bureau of Standards, Washington, D.C.

Judith A. Resnik, 28, Ph.D.
Akron, Ohio HS: Akron, Ohio
Xerox Corp., El Segundo, Calif.

Eugene A. Smith, 32, Captain, USAF
Utica, N.Y. HS: Middleville, N.Y.
Office of the Secretary of the Air Force
Los Angeles Air Force Station, Calif.

Robert C. Springer, 35, Major, USMC (pilot)
St. Louis, Mo. HS: Ashland, Ohio
Naval Air Test Center, Patuxent River, Md.

Norman E. Thagard, 34, M.D.
Marianna, Fla. HS: Jacksonville, Fla.
Medical University of South Carolina, Charleston, S.C.

James D. Van Hoften, 33, Ph.D.
Fresno, Calif. HS: Millbrae, Calif.
University of Houston, Houston, Tex.

Robert C. Ward, 35, Captain, USAF, M.D.
Homestead, Fla. HS: Miami, Fla.
Hill AFB, Utah

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NASA News

National Aeronautics and
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For Release:

IMMEDIATE

David Garrett
Headquarters, Washington, D.C.
(Phone: 202/755-3090)

Bob Gordon
Johnson Space Center, Houston, Texas
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RELEASE NO: 77-233

SHUTTLE ORBITER FERRY TEST FLIGHTS BEGIN

Four ferry test flights of the Space Shuttle Orbiter *Enterprise*, mated to the Boeing 747 Shuttle Carrier Aircraft (SCA), began this week Nov. 15 and continue Nov. 16, 17 and possibly 18 at NASA's Dryden Flight Research Center, Edwards, Calif.

Flights will measure the performance of the mated combination with a three degree forward angle between them. Previous flights were flown with a six degree angle.

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Mailed:
November 15, 1977

Data gathered will be used for planning the first ferry flight, now scheduled for March 1978, when Orbiter Vehicle 101 (the Enterprise) will be transported atop the 747 to NASA's Marshall Space Flight Center, Huntsville, Ala., for ground vibration tests.

Subsequent ferry flights will transport future Orbiters to NASA's Kennedy Space Center in Florida where they will be launched into space following their construction at the Rockwell International facility, Palmdale, Calif. After the first four orbital flights, which will be recovered at Dryden Center, the Orbiter used in those tests will also be returned to Kennedy atop the SCA.

In subsequent flights, Orbiters will return and land at Kennedy Center.

In addition to determining what the best speed and altitudes are for ferry flight configuration, other test conditions to be explored include holding pattern performance and engine-out performance, both in cruise and the landing/ takeoff pattern. The first flight primarily examined buffet and flutter effects on the SCA's horizontal tail.

Maximum speed for the series of four ferry flights should be approximately 724 kilometers per hour (450 miles per hour), peak altitude will be 7,925 meters (26,000 feet) and top takeoff weight will be 322,050 kilograms (710,000 pounds).

Crew for the 747 will be Fitzhugh Fulton, SCA commander, and Tom McMurtry, SCA pilot. Flight engineers will be Victor Horton and Skip Guidry. The four were members of the prime crew who flew most of the approach and landing test flights, completed Oct. 26, 1977.

NASA's Johnson Space Center, Houston, Texas, is responsible for the design, development and testing of the Space Shuttle Orbiter.

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For Release

IMMEDIATE

Kenn Morris
Headquarters, Washington, D.C.
(Phone: 202/755-3897)

RELEASE NO: 77-234

UNITED STATES, SOVIET SPACE TALKS SCHEDULED

NASA and the Soviet Union's Academy of Sciences will hold discussions Nov. 14-17 in Moscow concerning further cooperation in space. The talks are a result of an agreement reached by NASA and the Soviet Academy of Sciences May 11, 1977, following a meeting of representatives of the two agencies in Washington.

The U.S. delegation is headed by Dr. Noel Hinners, Associate Administrator for Space Science, NASA Headquarters. The Soviet delegation is expected to be led by Dr. Boris Petrov, Chairman of the Intercosmos Council of the Soviet Academy of Sciences.

-more-

Mailed:
November 14, 1977

The Moscow meetings are exploratory and their purpose is to identify candidate areas for studies to define a possible joint experimental program in the 1980s using spacecraft of the U.S. Space Shuttle type and the Soviet Salyut type.

The delegation will meet as two working groups; one on science and applications, chaired by Dr. Hinners, and one on operations, chaired by Dr. Glynn Lunney, manager of the Shuttle Payload Integration and Development Program Office at NASA's Johnson Space Center, Houston, Tex.

The two working groups will seek to define scientific areas for possible experimentation which might benefit from the flexible delivery capability and large capacity of the Space Shuttle and the capability for longer stay time in orbit represented by the Salyut.

In another area, the eighth annual meeting of a NASA-Soviet Space Biology and Medicine Working Group will be held Nov. 19-25 at NASA's Wallops Flight Center, Wallops Island, Va. Prior to the formal meeting, a workshop on simulated weightlessness will be held Nov. 16-18 in Bethesda, Md. The workshop and meeting are part of a continuing program under the 1971 Science and Applications Agreement between NASA and the Soviet Academy of Sciences.

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The meeting will focus on biomedical results, including the preliminary results of the Cosmos 936 flight on which U.S. experiments were flown; a briefing from the Soviets on Salyut 5/Soyuz 19 mission; and a U.S. briefing on a Spacelab Missions Demonstration Test. Participants will also discuss forecasting man's health state in weightlessness and the research approach to studying space motion sickness.

The U.S. delegation at the formal meeting will be headed by Dr. David Winter, NASA Director for Life Sciences. Dr. Rufus Hessberg, Director of Space Medicine, will head the U.S. workshop participants. The Soviet leader at both meetings will be Dr. Nikolai Gurovsky of the U.S.S.R. Ministry of Health.

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For Release

Nicholas Panagakos
Headquarters, Washington, D.C.
(Phone: 202/755-3680)

THURSDAY,
November 17, 1977

Peter Waller
Ames Research Center, Mountain View, Calif.
(Phone: 415/965-5091)

RELEASE NO: 77-235

THE BEGINNING: SERENE PROCESS OR CHAOTIC BANG?

Was the Big Bang explosion that marked the beginning of our universe violent and chaotic?

Many scientists think so.

But measurements made recently by a team of researchers using a high flying NASA aircraft suggest that our cosmos may have started more serenely -- with a powerful but tightly controlled and completely uniform expansion.

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Mailed:
November 14, 1977

Using ultrasensitive radio equipment aboard an Ames Research Center U-2 jet, the research team measured the cosmic microwave background--the radiation left over from the Big Bang, the initial, universe-forming event--and concluded that this initial event was a very smooth, almost serene process, with matter and energy uniformly distributed and expanding at an equal rate in all directions.

The findings were made by Drs. Richard Muller, George Smoot and graduate student Marc Gorenstein of the Lawrence Berkeley Laboratory and the University of California at Berkeley, who also designed and operated the radio equipment.

They also found that the Milky Way Galaxy, together with the solar system and Earth, appears to be hurtling through space at more than one million miles per hour towards the constellation Hydra.

"The radiation left over from the universe-forming event about 15 billion years ago is so uniform that it provides a universal reference for measuring this motion," says Gorenstein.

"Another major surprise is that the U-2 measurements seem to show that there is no rotation of the universe," says Smoot. "This is surprising because we can see that everything within the universe is rotating--planets, stars, and galaxies. If there is rotation, it has to be less than one hundred millionth of a rotation in the last billion years."

"Our measurements give a picture of an extremely smooth process," declare the researchers. "The big bang, the most cataclysmic event we can imagine, on closer inspection appears finely orchestrated. Either conditions before the beginning were very regular, or processes we don't yet know about worked to make the universe extremely uniform."

The uniformity was greater than one part in 1,000 for matter, one part in 3,000 for energy, and one part in 10,000 for expansion.

According to the currently accepted "big bang" picture, the universe began as a hot, incredibly dense mass containing all the matter in the universe. At a certain "initial" instant, the primeval fireball exploded in the vastest cataclysm imaginable.

As the universe continued its expansion and the temperature dropped, protons and neutrons began to fuse into nuclei and remained fused for increasingly longer periods of time. They formed first hydrogen, then deuterium and later helium. After millions of years, the material had cooled sufficiently to condense into galaxies and within the galaxies into stars and planets. As a consequence of the colossal explosion, the galaxies have continued to separate from each other, and thus form the expanding universe we observe. Those galaxies farthest from Earth appear to be traveling the fastest.

"The large scale regularity we have found in the expansion of the universe makes the million-mile-an-hour random local motion we have detected for the Earth and our galaxy all the more surprising," Smoot says.

The U-2 plane, at an altitude of 19,800 meters (65,000 feet), flies above 90 per cent of the Earth's atmosphere where these sensitive experiments must be conducted. In charge of the flights for Ames Center was James Cherbonneaux, U-2 Project Manager. When it is not investigating the cosmos, the U-2 jet is used for agricultural and Earth resources photography.

The project was funded by the Department of Energy and NASA. Measurements so far have covered almost the entire sky over the northern hemisphere, half the celestial sphere.

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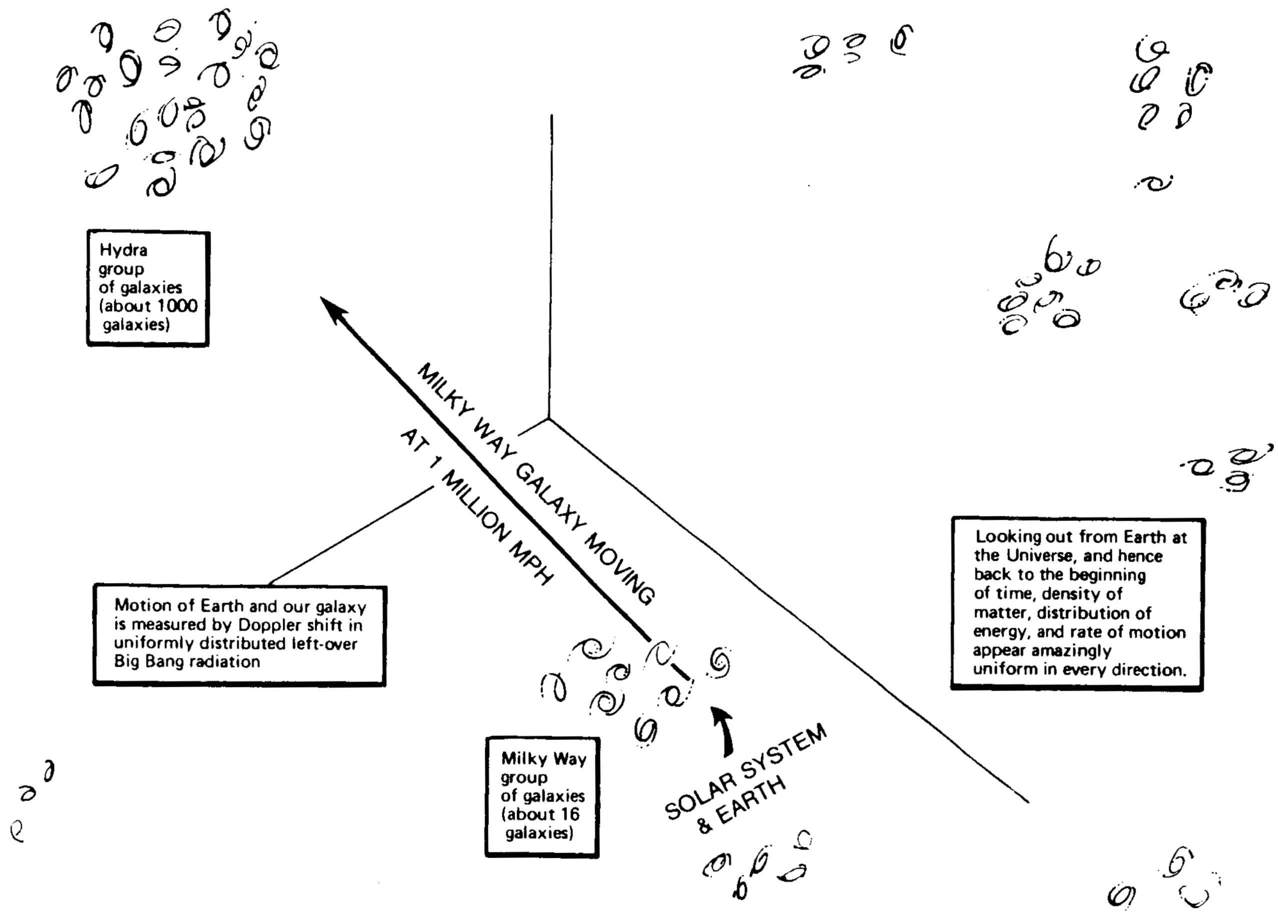
SCHEMATIC VIEW OF OUR SECTOR OF THE UNIVERSE



NASA Photo No: 77 H 706

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RELEASE NO: 77-236

TENTH GROUP OF ASTRONAUT APPLICANTS AT JOHNSON CENTER THIS WEEK

The tenth group of Space Shuttle astronaut applicants is scheduled to report to NASA's Johnson Space Center, Houston, Texas, this week for physical examinations and individual interviews.

This group includes 24 mission specialist applicants and one pilot applicant. Eight of the applicants in this group are military and one is a woman.

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Mailed:
November 15, 1977

There were 8,079 applicants for the Space Shuttle astronaut program. From these, 208 have been selected to be brought to Johnson Center in groups of 20 or more for further screening.

Including this group of 25 applicants, 80 pilot and 128 mission specialist applicants (21 were women) will have been at Johnson Center for further screening prior to the final selection.

Notification of selection of as many as 20 astronaut candidates in each of the categories -- pilot and mission specialist -- will be made in December. The candidates will report at a later date to Johnson Center for a two-year evaluation and training period before their final selection as astronauts.

The name, age, degrees and/or military rank, place of birth, high school (HS) and current duty station or place of employment of the individuals in this tenth group are:

William B. Atwood, 30, Ph.D.
Nashua, N.H. HS: Williamstown, Mass.
CERN, EP Division, Geneva, Switzerland

Robert C. Belcher, 28
Del Rio, Texas HS: Brackettville, Texas
University of Texas (graduate student), Austin, Texas

Ronald S. Bird, 35, lieutenant commander, USN, Ph.D.
Ann Arbor, Mich. HS: Clearwater, Fla.
Pacific Missile Test Center, Pt. Mugu, Calif.

James F. Buchli, 32, captain, USMC
New Rockford, N.D. HS: Fargo, N.D.
Naval Air Test Center, Patuxent River, Md.

John T. Cox, 33. Ph.D.
New York, N.Y. HS: Sherman Oaks, Calif.
NASA/Johnson Space Center, Houston, Texas

Andrew C. Cruce, 34, Ph.D.
Fresno, Calif. HS: Tulsa, Okla.
Naval Air Test Center, Patuxent River, Md.

David J. Diner, 24, Ph.D.
New York, N.Y. HS: Bronx, N.Y.
California Institute of Technology, Pasadena, Calif.

Ayre R. Ephrath, 35, Ph.D.
Czechoslavakia HS: Tel Aviv, Israel
University of Connecticut, Storrs, Conn.

Richard S. Galik, 26, Ph.D.
Hackensack, N.J. HS: Lyndhurst, N.J.
Rittenhouse Labs, University of Pennsylvania,
Philadelphia, Pa.

Frederick D. Gregory, 36, major, USAF (pilot)
Washington, D.C. HS: Washington, D.C.
Armed Forces Staff College, Norfolk, Va.

Hamilton Hagar, Jr., 37, Ph.D.
New York, N.Y. HS: Sarasota, Fla.
Jet Propulsion Laboratory, Pasadena, Calif.

John F. Jones, Jr., 31, Ph.D.
Detroit, Mich. HS: Berkley, Mich.
Sandia Laboratories, Livermore, Calif.

Byron K. Lichtenberg, 29
Stroudsburg, Pa. HS: Stroudsburg, Pa.
Massachusetts Institute of Technology, Cambridge, Mass.

Richard E. Maine, 26
Louisville, Ky. HS: Charlottesville, Va.
NASA/Dryden Flight Research Center, Edwards, Calif.

-more-

Ronald E. McNair, 27, Ph.D.
Lake City, S.C. HS: Lake City, S.C.
Hughes Research Laboratories, Malibu, Calif.

Joseph K. E. Ortega, 31, Ph.D.
Trinidad, Colo. HS: Denver, Colo.
University of Colorado, Boulder, Colo.

Harold S. Rhoads, 31, captain, USAF, Ph.D.
Lexington, Ky. HS: Lexington, Ky.
4950th Test Wing, Kirtland AFB, N.M.

David W. Richards, 34, M.D., Ph.D.
San Pedro, Calif. HS: Demarest, N.J.
North Broward Emergency Physician, Ft. Lauderdale, Fla.

Paul B. Schlein, 33, lieutenant commander, USN, Ph.D.
Stockton, Calif. HS: Manteca, Calif.
NAVELEX, Washington, D.C.

Alan L. Sessoms, 30, Ph.D.
New York, N.Y. HS: New York, N.Y.
Harvard University, Cambridge, Mass.

Joseph A. Strada, 32, lieutenant commander, USN, Ph.D.
Philadelphia, Pa. HS: Cherry Hill, N.J.
SAMSO, Los Angeles Air Force Station, Calif.

Kathryn D. Sullivan, 26
Paterson, N.J. HS: Woodland Hills, Calif.
Dalhousie University (graduate student), Halifax, Nova Scotia

David J. Vieira, 27, Ph.D.
Oakland, Calif. HS: Castro Valley, Calif.
Lawrence Berkeley Lab, University of California, Berkeley, Calif.

James R. Walton, 36, captain, USAF, Ph.D.
Ithaca, N.Y. HS: Pittsburgh, Pa.
366th Tactical Fighter Wing, Mountain Home AFB, Idaho

Charles R. Weir, 29, lieutenant, USCG
Sidney, Neb. HS: Gurley, Neb.
Oceanographic Unit, U.S. Coast Guard, Washington, D.C.

-end-

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For Release

IMMEDIATE

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Linda Peterson
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RELEASE NO: 77-237

ASSESSMENT OF JOINT U.S.-CANADIAN COMMUNICATIONS SATELLITE SET FOR NOV. 29-DEC. 1 IN OTTAWA

Performance of the world's most powerful communications satellite, now aloft almost two years, will be assessed by Canada and the United States at a three-day symposium in Ottawa, Nov. 29, 30 and Dec. 1.

Purpose of the first assessment meeting for the Communications Technology Satellite (CTS) will be "to provide a forum in which experimenters can present the results of their experiments and promote discussion of the social, technical and economic aspects of communications using satellites of the CTS type, and to inform the public." Canada and the U.S. share the use of the satellite.

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Mailed:
November 16, 1977

NASA's Lewis Research Center, Cleveland, Ohio, is responsible for development of the satellite's key component, a transmitter tube 10 to 20 times more powerful than any other performing today in a communications satellite. Lewis Center also manages all U.S. experiments utilizing the CTS.

The Royal Society of Canada will sponsor the symposium in cooperation with the Canadian Department of Communications and NASA.

Opening the sessions at 9:30 a.m. Tuesday, Nov. 29, will be R. E. Folinsbee, president of the Royal Society of Canada. Dinner speaker for that evening will be The Honorable Jeanne Sauve, Canadian Minister of Communications. The top NASA official present, who also will speak on Tuesday, will be Dr. Anthony J. Calio, Associate Administrator for Applications.

Launched in January 1976, CTS operates in a new frequency band at power levels 10 to 20 times higher than for other such satellites. This higher broadcast power makes it possible to use much smaller and far less expensive ground receiving equipment.

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The satellite played a key role in aiding victims of the Johnstown flood this past July, permitting direct audio contact between the disaster area and the American Red Cross headquarters in Washington, D.C. at a time when all commercial communication lines were out of service. It was the first time in the satellite's history that it had been employed for disaster aid. The CTS is customarily used in experiments for health, education, business and similar purposes, involving two-way television and voice contact.

Other notable experiments transmitted by the CTS include teleconferencing in April of this year of proceedings of the 55th annual international convention of the Council for Exceptional Children (CEC) to school audiences in four southern cities and teleconferencing four sessions of the International Telecommunications Exposition (INTELCOM 77) in October from Atlanta, Ga., to Bethesda and Greenbelt, Md., and Ottawa, Canada.

Lewis' role in managing the U.S. experiments includes use of a portable Earth terminal, a converted over-the-road van resembling a television studio which traverses the country to hook up the event to be telecast with the satellite.

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For Release:

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TUESDAY, A.M.
November 29, 1977

Don Witten
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/982-4955)

RELEASE NO: 77-238

SPACE RESEARCH LEADS TO HANDHELD X-RAY DEVICE

A concept fostered by a NASA scientist for studying X-ray sources in space has led to a handheld X-ray instrument which produces an instant image with a small source of radioactive material.

Powered by a single pen size battery, the prototype model of the rugged device exhibits high potential for screening and other uses in medicine, dentistry and areas of industry. The most obvious promise of the unique unit is for emergency and other field use where a quick fluoroscopic examination is desirable.

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Mailed:
November 18, 1977

Potential applications of the portable instrument range from examination of a football player's possible bone injury on the field to detection of welding defects or gas leaks in pipes.

The device was developed by Dr. Lo I Yin, an X-ray researcher at NASA's Goddard Space Flight Center, Greenbelt, Md. He presented the first public details of the patented instrument Nov. 29 at a meeting of the American Nuclear Society in San Francisco, Calif.

The new device is called a Lixiscope (for Low Intensity X-ray Imaging Scope). It is based on a concept under study to research energy sources in space by converting their X-rays to visible images.

"The concept was not feasible until the declassification of an image intensifier developed by the Army's Night Vision Laboratory at Ft. Belvoir, Va.," Dr. Yin said.

"Any device developed for X-ray astronomy studies, where there is a scarcity of X-rays, should have technology of obvious value in medical fluoroscopy where there are many X-rays," Yin said.

Several research institutes in the dental and medical field are expected to participate in a cooperative effort to evaluate the Lixiscope. They include the National Institute of Dental Research (NIDR), Bethesda, Md., and Howard University's College of Dentistry, Washington, D.C. Others are the Cancer Research Center of Howard University's Medical School and Duke University Medical Center, Durham, N.C.

"The Lixiscope has a variety of potential applications, including patient screening, root canal analysis and possibly the monitoring of surgical procedures," said Dr. Richard Webber, Chief of NIDR's Clinical Investigations Branch.

Researchers at NIDR already have designed one configuration of the new device to be tested for dental application.

Other researchers at Howard University's Cancer Research Center would like to compare the Lixiscope with existing X-ray techniques for preliminary screening of soft tissue tumors.

"The device also shows promise for the detection of foreign bodies as well as for screening bone fractures," said Dr. Jack E. White, Head of Howard's Cancer Research Center.

-more-

According to White, use of the device for screening bone fractures could help cut down total X-ray dosages to the patient. Usual procedure now is to order X-ray images showing the limb or body from a variety of angles to insure that the proper aspect is covered.

The demonstration model of the Lixiscope was developed under direction of the Goddard Technology Utilization Office as part of the NASA Technology Utilization Program whose purpose is to identify and foster the transfer of promising aerospace technology for other uses.

Although the device is not on the market, it is estimated that production units could cost less than $5,000 each based on existing component costs.

No new technology was required for the Lixiscope. In addition to the night vision image intensifier, it incorporates other off-the-shelf items including a radioactive source and an X-ray phosphor screen.

The pull of a trigger unshields the radioactive source, sending a low dosage of X-rays into the object being examined. The X-rays passing through the object are absorbed by the phosphor screen which converts them to visible light.

The night vision unit, which employs fiber optics, intensifies and channels the visible light to its viewing screen for image display.

Because of the high intensification capability of the unit, a small radioactive X-ray source of 10 to 20 millicuries can be used. Sources are interchangeable to facilitate use of the Lixiscope for a variety of applications.

Instant pictures of X-rayed objects can be made quickly with an attached camera, using a radioactive exposure a thousand times weaker than with a conventional X-ray machine. Prolonged examination of a patient with the Lixiscope obviously increases the dosage.

Co-authors of Dr. Yin's paper, entitled "A Portable, Low-Dose, X-ray Imaging Device," include Dr. Jacob Trombka of Goddard Center and Stephen M. Seltzer, a consultant in theoretical calculations from the National Bureau of Standards.

Photographs to illustrate this news release will be distributed without charge only to media representatives in the United States. They may be obtained by writing or phoning:

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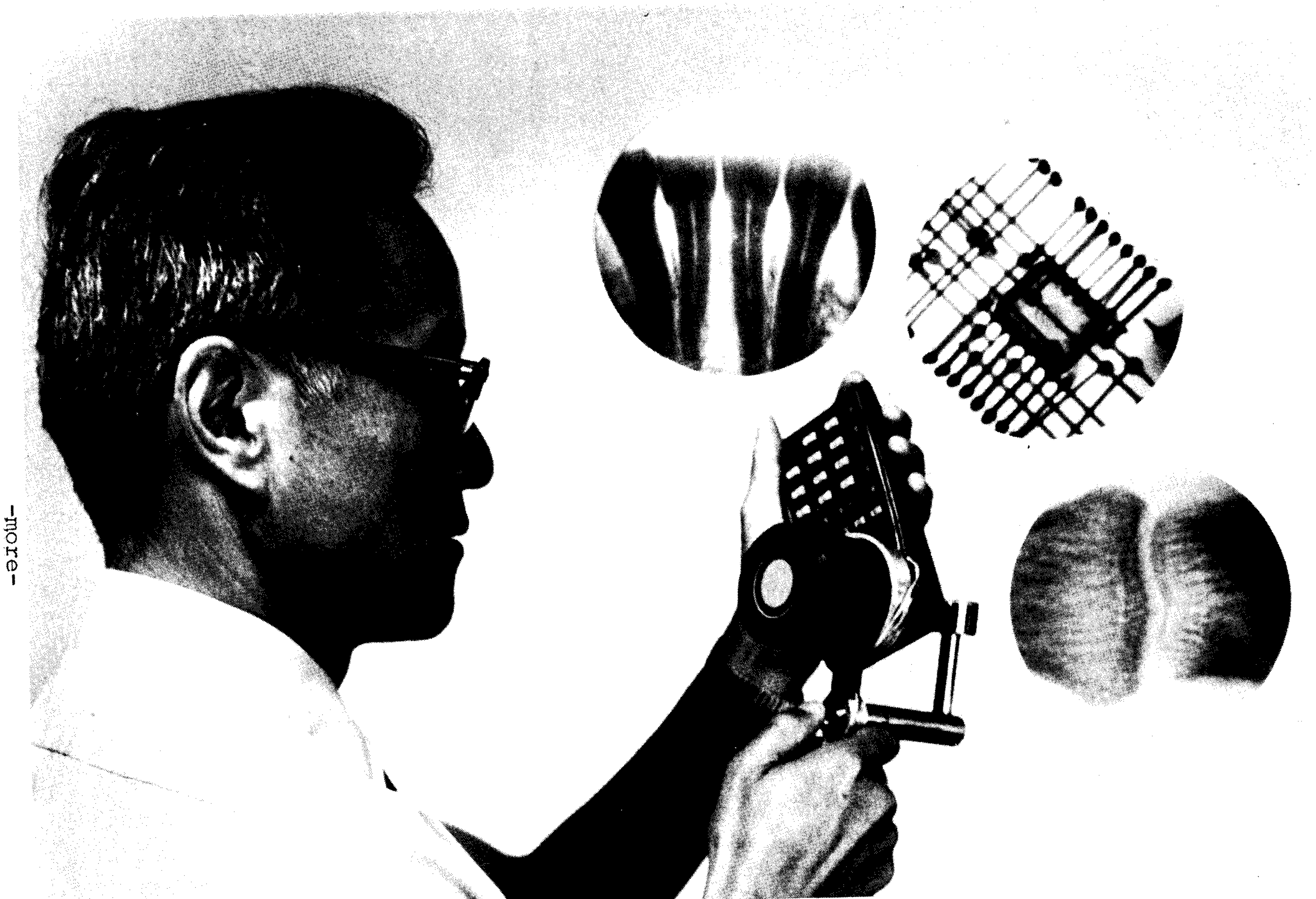
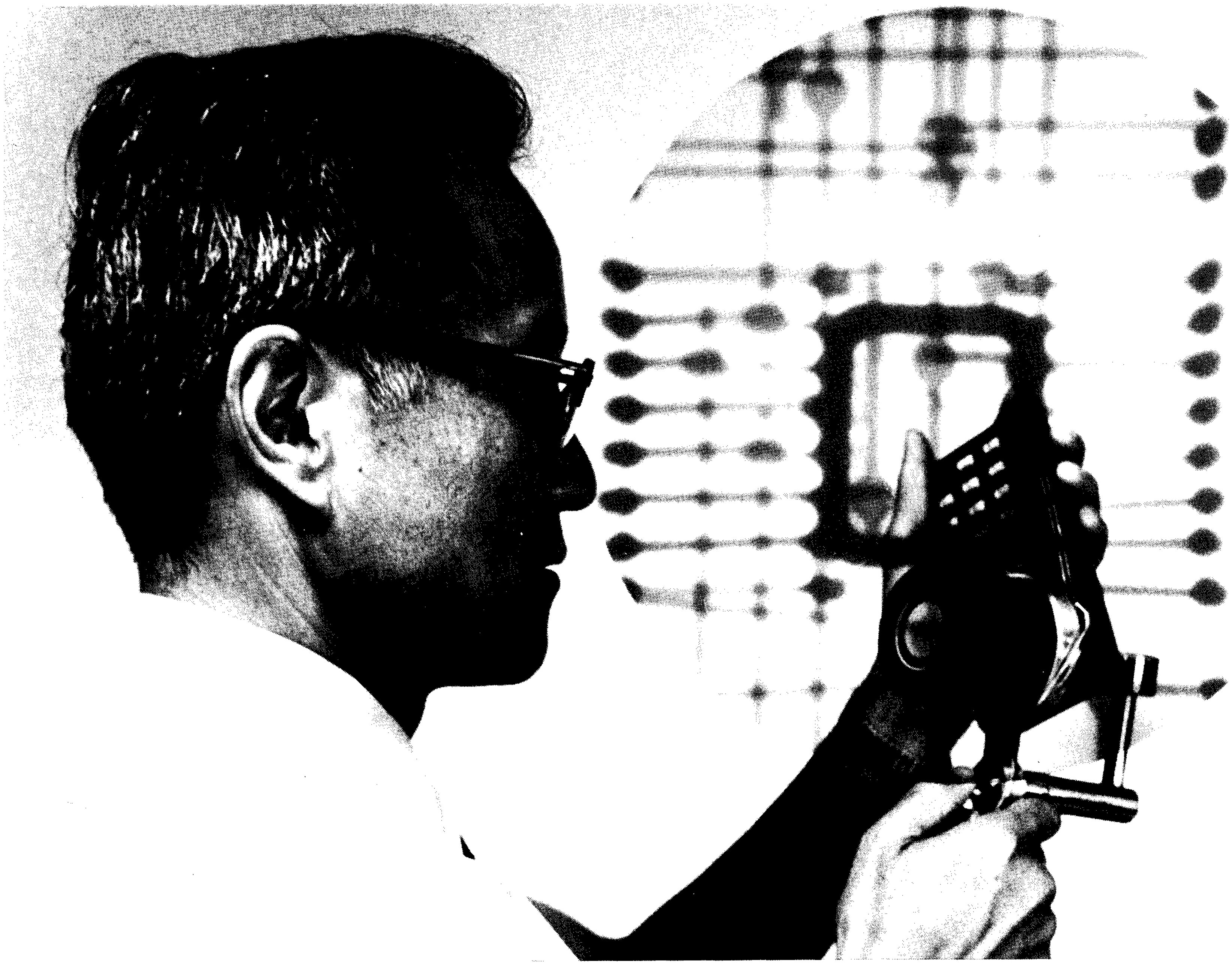


COMPACT X-RAY DEVICE -- Dr. Lo I Yin of NASA's Goddard Space Flight Center, Greenbelt, Md., examines a hand calculator with a demonstration model of his Lixiscope (Low Intensity X-ray Imaging Scope). Superimposed on the photo are images produced by the device. They include incisor teeth, integrated circuitry and the main joint of a forefinger.

NASA Photo: 77-H-713



VERSATILE X-RAY DEVICE -- Dr. Lo I Yin of NASA's Goddard Space Flight Center, Greenbelt, Md., examines a hand calculator with a demonstration model of his Lixiscope (Low Intensity X-ray Imaging Scope). Superimposed on the photo is an enlarged image of integrated circuitry in the background.

NASA Photo: 77-H-714

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For Release

IMMEDIATE

RELEASE NO: 77-239

NASA SELECTS 18 SCIENTISTS FOR SPACE TELESCOPE

Eighteen scientists have been tentatively selected by NASA to participate in the design and early operational phases of its Space Telescope Project.

To be launched into Earth orbit in 1983 by the Space Shuttle, the 10-ton observatory will make astronomical observations deeper into space and with more detail than has ever before been possible.

The Space Telescope should permit scientists to solve some of the mysteries relating to the structure, origin, evolution and energy processes of the universe, which could never be approached with observatories below the obscuring veil of Earth's atmosphere.

-more-

Mailed:
November 21, 1977

With the Space Telescope, astronomers should be able to observe some 350 times the volume of space that can be seen now with the largest ground-based telescope.

Once placed in orbit, the telescope will be operated remotely from the ground. However, it will be designed to permit maintenance and the change of instruments by a space-suited astronaut and to be retrievable by the Space Shuttle for return to Earth for extensive overhaul and subsequent relaunch. These features should allow the Space Telescope to serve as an in-space astronomical observatory for more than a decade.

The 2.4-meter (8-foot)-diameter Space Telescope will be capable of accommodating five different instruments at its focal plane. The observatory will weigh 9,100 kilograms (10 tons) and will orbit the Earth at an altitude of approximately 500 kilometers (310 miles), above the obscuring effects of the atmosphere. It will thus be available to all astronomers for observations which cannot be made from the surface of the Earth.

Scientists have been chosen to head teams to participate individually in a variety of categories as follows:

Investigations Definition Teams: These teams consist of principal investigators, co-investigators and supporting staffs who will design and develop the focal plane scientific instruments. They will also carry out major scientific investigations.

Individual Co-Investigators: These are scientists who had not been affiliated with an investigation definition team prior to selection but who will be assigned to a team now.

Astrometry Science Team: This team will be responsible for assuring that the fine guidance system will adequately perform astrometric functions as required.

U.S. Members of European Space Agency Faint Object Camera Instrument Science Team: The two U.S. members chosen will represent the American astronomical community.

Telescope Scientists: Two scientists have been chosen with strong backgrounds in optical instrumentation. They will be responsible for interpreting the scientific performance requirements in terms of telescope design specifications.

-more-

Data and Operations Team Leader: Will lead a team of representatives appointed by each principal investigator to review or establish requirements and specifications for instrument control systems, flight operations and ground data handling systems.

Interdisciplinary Scientists: Designed to give breadth to the guidance of the Space Telescope Project beyond the concerns of the individual principal investigators and the technical specialists. The four chosen will be responsible for a broad scientific overview of the observatory's development.

Investigators selected by NASA, their respective institutions and their areas are:

Principal Investigators	Institution	Area or Team
Dr. James Westphal	California Institute of Technology	Wide Field Camera Team
Dr. Richard Harms	University of California, San Diego	Faint Object Spectroscopy Team Leader
Dr. John Brandt	Goddard Space Flight Center	High Resolution Spectroscopy Team Leader
Dr. Robert Bless	University of Wisconsin	High Speed Photometry Team Leader

Principal Investigators	Institutions	Area or Team
Dr. William H. Jefferys	University of Texas at Austin	Astrometry Team Leader
Dr. James L. Elliot	Cornell University	Individual Co-Investigator on Photometry
Dr. Bruce Margon	University of California, Los Angeles	Individual Co-Investigator on Faint Object Spectrograph Team
Dr. Arthur F. Davidson	Johns Hopkins	Individual Co-Investigator on Faint Object Spectrograph Team
Dr. P. Kenneth Seidelmann	U.S. Naval Observatory	Individual Co-Investigator on Wide Field Camera Team
Dr. Daniel J. Schroeder	Beloit College	Telescope Scientist
Dr. William G. Fastie	Johns Hopkins University	Telescope Scientist
Dr. Edward J. Groth	Princeton University	Data/Operations Team Leader
Dr. Philippe Crane	European Southern Observatory	U.S. member/FOC Team
Dr. Ivan R. King	University of California, Berkeley	U.S. member/FOC Team
Dr. John N. Bahcall	Institute for Advanced Study	Interdisciplinary Scientist
Dr. John Caldwell	State University of New York at Stony Brook	Interdisciplinary Scientist
Dr. Malcolm Longair	Cambridge University	Interdisciplinary Scientist
Dr. David L. Lambert	University of Texas	Interdisciplinary Scientist

The planned payload is composed of two cameras, two spectrometers and a photometer. The Faint Object Camera, provided by European Space Agency (ESA) and the Wide Field Camera are distinguished by their fields of view, spatial resolution and wavelength range. Both instruments cover the ultraviolet and blue regions of the spectrum. The Wide Field Camera covers the red and near-infrared regions as well. The Faint Object Camera has a very small field of view but can use the highest spatial resolution which the Space Telescope optics can deliver. The Wide Field Camera covers a field at least 40 times larger but with a resolution degraded by a factor of two to four.

The two spectrographs provide a wide range of resolutions which would be impossible to cover in a single instrument. Only the Faint Object Spectrograph covers the visible and red regions of the spectrum.

The fifth instrument is a simple, single channel photometer which can be used both for calibrating the other instruments and for very high speed photometry. By operating while other instruments are observing, this instrument can also collect information on the brightness of the galactic background, which can be generally useful.

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A Space Telescope Science Working Group will be formed to provide scientific guidance to the project. The group will be composed of the various team leaders, the two telescope scientists, the interdisciplinary scientists and appropriate project personnel.

NASA's Marshall Space Flight Center, Huntsville, Ala., will have overall management responsibility for the Space Telescope. NASA's Goddard Space Flight Center, Greenbelt, Md., will be responsible for managing the development of the scientific instruments and for the operational aspects of the observatory. The European effort will be managed by the European Space Technology Center at Noordwijk in the Netherlands.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

Mary Fitzpatrick
Headquarters, Washington, D.C.
(Phone: 202/755-8370)

For Release:

IMMEDIATE

RELEASE NO: 77-240

RAYMOND KLINE NAMED NASA ASSOCIATE ADMINISTRATOR FOR MANAGEMENT OPERATIONS

Raymond A. Kline has been named to the new NASA post of Associate Administrator for Management Operations, effective Nov. 20, 1977.

In his new position, Kline will be responsible for providing an integrated focus for institutional management and for the management of institutional resources in support of NASA programs.

Kline had served as Acting Associate Administrator for Center Operations from July 1977 until that position was abolished in the recent reorganization of NASA Headquarters.

-more-

Mailed:
November 18, 1977

In 1968, Kline came to Headquarters after six years on the executive staff of Dr. Wernher von Braun at NASA's Marshall Space Flight Center in Huntsville, Ala.

Among his previous Headquarters assignments were: Assistant Administrator for Institutional Management; Assistant Associate Administrator for Center Operations (Systems Management); and Assistant Associate Administrator for Organization and Management.

A native of New Ringgold, Pa., Kline received an A.B. degree in political science from Lebanon Valley College in Pennsylvania; an LL.B. degree in law from George Washington University, Washington, D.C.; and did graduate work in public administration at that school. He is a member of the District of Columbia Bar.

During World War II and the Korean War, he served in the Army and before joining Dr. von Braun's staff, he had held various management positions with the Army Missile Command, Huntsville, Ala.

He and his wife, the former Jeanelle Batley of Birmingham, Ala., make their home in Rockville, Md. They are the parents of two children.

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NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
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For Release

IMMEDIATE

David Garrett
Headquarters, Washington, D.C.
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Hugh Harris
Kennedy Space Center, Fla.
(Phone: 305/867-2468)

RELEASE NO: 77-241

NOTE TO EDITORS:

NEXT ATLAS/CENTAUR LAUNCH SCHEDULED EARLY IN JANUARY

The next launch of an Atlas Centaur rocket from NASA's Kennedy Space Center, Fla., has been rescheduled for no earlier than Jan. 6. The payload will be an Intelsat IV-A, commercial communications satellite.

Scheduled for launch in November, the mission was originally delayed by the investigation of the failure of the previous Atlas Centaur launch Sept. 29. The investigation of that failure is nearly complete and the findings are scheduled to be presented to Associate Administrator for Space Transportation Systems, John Yardley, at NASA Headquarters in early December.

-more-

Mailed:
November 21, 1977

The present decision to move the next launch to January is not related to the investigation, however. Recently some faulty feed-back transducers used in the Atlas actuators for engine control were found through routine testing. The new date will allow time to remove any transducers from that manufacturing batch from flight hardware and revalidate the engine systems.

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NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

For Release:

Nicholas Panagakos
Headquarters, Washington, D.C.
(Phone: 202/755-3680)

IMMEDIATE

RELEASE NO: 77-242

NOTE TO EDITORS:

FIRST HEAO RESULTS BRIEFING SET FOR NOV. 29

A news briefing on first results from the scientific experiments aboard NASA's High Energy Astronomy Observatory, HEAO-1, will be held at 11:30 a.m. Tuesday, Nov. 29, in the Sixth Floor Auditorium, NASA Headquarters, Washington, D.C.

Participants will include Dr. Noel S. Hinners, NASA Associate Administrator for Space Science; Dr. Frank B. McDonald, Goddard Space Flight Center, HEAO Project Scientist; and the principal investigators for the major experiments aboard HEAO.

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Mailed:
November 21, 1977

HEAO-1 was launched into Earth orbit Aug. 12, 1977, inaugurating a three-mission program to study some of the most intriguing mysteries of the universe -- pulsars, quasars, exploding galaxies and black holes in space.

Believed to be the heaviest Earth-orbiting satellite ever launched, the observatory carries scientific instruments capable of detecting, with high sensitivity and resolution, X-rays emitted by stellar sources throughout the universe. The spacecraft, rotating end-over-end, will have surveyed the entire sky in six months.

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NASA Fact Sheet

National Aeronautics and Space Administration

Nicholas Panagakos
Headquarters, Washington, D.C.
(Phone: 202/755-3680)

RELEASE NO: 77-243

EXPLODING STARS, PULSARS AND BLACK HOLES IN SPACE

CONTENTS:

November 1977

EXPLODING STARS, PULSARS AND BLACK HOLES IN SPACE

Supernovas

A supernova is a large star at life's end, whose final collapse is a cataclysmic event that generates a violent explosion, blowing the innards of the star out to space. There the material of the exploded star mixes with the primeval hydrogen of the universe. Later in the history of the galaxy, other stars are formed out of this mixture. The Sun is one of these stars; it contains the debris of countless others that exploded before the Sun was born. The last supernova observed in the Milky Way Galaxy -- of which our solar system is a part -- was seen by Johannes Kepler in 1604. Supernova explosions, resulting in neutron stars and black holes, occur with massive stars; stars smaller than, say, our Sun -- which is an average-sized star, probably become white dwarfs.

Pulsars and Neutron Stars

Discovered in 1967, pulsars emit radio signals whose pulsations are extremely precise. The evidence suggests that pulsars are fast-spinning neutron stars.

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These are compact bodies of densely packed neutrons (atomic particles having no electric charge), believed to form when a large star burns up its fuel and collapses. Containing the mass of a star in a sphere 10 miles in diameter, they are so closely packed that a spoonful of material from the center would weigh a billion tons. A neutron star, or pulsar, has been located in the center of the Crab Nebula, a glowing cloud which is still expanding from a supernova reported by the Chinese in 1054.

Black Holes

Believed to be the final stage in the collapse of a dying star which was very massive. The collapsed star's material is so densely packed -- even more so than a neutron star -- and the gravitational force so great that even light waves are unable to escape from the surface of a black hole. All external evidence of its presence disappears. Because black holes emit no light or other radiation, their existence -- predicted by the laws of relativity -- cannot be confirmed by direct observation, but it can be inferred. Astronomers have identified a powerful X-ray source in the constellation Cygnus. Some suspect the source, which has been labeled Cygnus X-1, may be just such a black hole.

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It appears to be rotating with a visible star around a common center of gravity. Scientists believe material from the glowing star is being drawn into the black hole with such force that the material becomes hot enough to emit X-rays.

Red Giant

An aging star approaching the end of its life. The beginning of the end comes when the star has exhausted much of the hydrogen near its core and starts to burn the hydrogen in its outer layers. This process causes the star to gradually turn red and swell to 100 times its previous size, pouring out prodigious amounts of energy. Betelguese, in the constellation Orion, is such a red giant visible to the naked eye. What happens after its hydrogen is consumed depends on the size of the star. A small star contracts and becomes a white dwarf. A large star becomes a supernova, blowing its innards into space.

White Dwarf

A small aging star in the final stages of its life. Having exhausted all its hydrogen, the star cannot generate sufficient pressure at its center to balance the crushing force of gravity. The star collapses under the force of its own weight and remains collapsed.

Such a collapsed star, at its life's end, is called a white dwarf. (In a large star, the final collapse generates the supernova explosion outlined earlier.) White dwarfs contract to about the size of the Earth, a few thousand miles in diameter, and then spend many years gradually losing their heat. Eventually, the white dwarf's fires burn out entirely, leaving behind a black dwarf.

Quasars

Astronomers are still baffled by the nature of quasars, but many believe that among observable objects they are the most remote in the universe. They look like stars when viewed through an optical telescope, but emit more energy at radio frequencies than the most powerful galaxies known. According to calculations, if they are as distant as many astronomers think they are, the total amount of energy emitted by a quasar in one second (10^{47} ergs/sec) would supply all of Earth's electrical energy needs for a billion years.

Radio Galaxies

Located on the fringes of visibility, they emit radio waves millions of times more powerful than the emissions of a normal spiral galaxy. No one knows what these peculiar galaxies are. Several of them broadcast with such huge power that a sizeable fraction of the nuclear energy locked up in their matter must be going completely into the production of radio waves.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SCIENCE NEWS BRIEFING

Heao 1

HIGH ENERGY ASTRONOMY OBSERVATORY

12:00 P.M.
29 November 1977
Room 6104
400 Maryland Avenue
Washington, D.C.

PARTICIPANTS

Dr. Elihu Boldt
Goddard Space Flight Center
Cosmic Ray Experiment

Dr. Hale Bradt
Massachusetts Institute of Technology
Scanning Modulation Collimator Experiment

Dr. Herbert Friedman
U.S. Naval Research Laboratory
Large X-Ray Survey Experiment

Dr. Gordon Garmire
California Institute of Technology
Cosmic Ray Experiment

Dr. Noel W. Hinners
NASA Headquarters
Associate Administrator for Space Science

Dr. Frank G. McDonald
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HEAO-1 Project Scientist

Mr. Nicholas Panagakos
Public Affairs Officer
Office of Space Science

Dr. Laurence Peterson
University of California at San Diego
Large X-Ray and Low-Energy
Gamma Ray Experiments

P R O C E E D I N G S

MR. PANAGAKOS: I am Nick Panagakos, the Public Affairs Officer for the Office of Space Science, and this is a news briefing on first results from the High Energy Astronomy Observatory. This briefing is also being transmitted one way to the Marshall Space Flight Center in Huntsville, Alabama, which manages the project for NASA, and to the Kennedy Space Center in Florida.

Transcripts of this briefing will be available in about a week and as usual, if you are on our mailing list, you will get them automatically. If you are not, we will have brown envelopes in the back of the room, if you will address them to yourself and leave them there, we will see that you get a transcript.

I apologize for starting late. I realize that many of you ran cross-town to get here after a briefing at the Department of Energy, and I also realize that it is the noon hour and a lot of stomachs are going to start grumbling pretty soon, so we will make it short and sweet and hopefully to the point.

Today's participants are Dr. Noel Hinners, who is NASA's Associate Administrator for Space Science here at NASA Headquarters; Dr. Frank McDonald of the Goddard Space Flight Cente , who is the HEAO-1 Project

Scientist; Dr. Herbert Friedman, U.S. Naval Research Laboratory, Principal Investigator on the large x-ray survey experiment; Dr. Elihu Boldt, Goddard Space Flight Center; and Dr. Gordon Garmire of the California Institute of Technology, who are on the cosmic ray experiment; Dr. Hale Bradt of M.I.T., who is Principal Investigator of the scanning modulation collimator experiment; and Dr. Laurence Peterson of the University of California at San Diego, who is Principal Investigator for the large x-ray and low energy gamma ray experiments.

We will start with Dr. Hinners. Noel?

DR. HINNERS: I think the sequence of your visits are quite appropriate this morning. If you came from the Department of Energy, I think you will find that there wasn't much energy in evidence. When you come to NASA and hear about the high energy astrophysics that is going on, I think you will see that we have sources of energy that would confound the physicists trying to create a little more here on earth.

But seriously, it was not very long ago that we were worried about whether or not we would ever get the HEOA launched. If you will recall, the rate gyros were giving us fits, not working properly, a new design that was overcome. We had a four-month launch delay, and then we got our launch off very thankfully before the next Atlas Centaur launch, which had an INTELSAT on it.

Everything is up and working well. This at the press conference -- I would rather call it a briefing or maybe a tutorial -- will for many of you on Viking I think have some similar aspect, where you are participants in the conduct, if you will, of real time science, where each day you would see some of the data come in and while the news people pressed the scientists for rapid explanations, you were told, "Now, wait, you have got to understand what is coming through here for all the results to come in," and I think what you are seeing today is somewhat along those lines.

The HEAO is in very preliminary stages, but there is enough new information to let you know how it is working, the kind of information that is coming, and some of the prospects for the future, so in that sense, you are going to be participants in watching the science unravel.

In another respect, I think one has to look on HEAO in terms of the optical astronomy of 50 years ago, where the astronomers with the new telescopes, the larger telescopes that were starting to come into existence, started to do sky surveys, and that data, even until today, is providing the firm foundation for many of the new observations that are being made.

With that, I think I will stop and turn it over to the experts, Frank McDonald, the Project Scientist, for HEAO.

DR. MCDONALD: I want to make just a couple of brief introductory remarks and then turn the podium over to Herb Friedman. X-ray astronomy has really given us a very remarkable view of our own universe quite unexpectedly, ranging from the study of compact objects, white dwarfs, neutron stars down to possible black holes, to looks at distant galaxies.

The explosion in this knowledge really began with Uhuru. There have been a number of second generation missions, SES-3 being the most successful; the large number of X-ray experiments on OSO-8, and also the British satellite, Aerial-5. (Ariel)

So HEAO-1 comes in then as the third generation mission, and its primary object is to do a survey mission where it looks at the whole sky. It will complete this survey after the end of the first six months. As you will see, the sky is complex and variable enough that one will want to repeat this, hopefully, and that we will be able to stop this scanning mission and point at objects up to for a period of time with quite a reasonable degree of accuracy.

So I would like to tell you a little bit about the experiments.

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(Slide.)

DR. MCDONALD: In the first view graph is of the spacecraft itself. The experiments really dovetail very nicely. There is from the Naval Research Laboratory, there is a very large experiment with great sensitivity to look for the new sources, and it consists of seven modules, each with an area of some 2,200 square centimeters, and covered in energy range from roughly .15 kilovolts up to 20 kilovolts.

(Slide.)

DR. MCDONALD: The next experiment does two experiments, which is a combination between the California Institute of Technology, the University of California at Berkeley, and the Goddard Space Flight Center, does spectroscopy in a broad band, such as it can look at iron-line emission. It also looks in detail at one of the most dominant features of the X-ray sky, which is the all-pervading diffuse X-ray background whose source is not yet understood.

Now, the way that you tie these X-ray observations to the rest of astronomy and astrophysics is through accurate source location, and that is the object of the third experiment, the A-3 experiment, which is a joint experiment between the Harvard-Smithsonian Astrophysical Observatory and M.I.T., where they have been able to achieve very accurate source locations, tie in the optical object or the radio object, and thus connect X-ray observations to the rest of the astronomical world.

Then as you change energy, as you go up in energy, the physical processes begin to change. You go from thermal processes up to non-thermal processes, such as synchrotron ~~synchetron~~ emission, possible nuclear lines, and so the A-4 experiment, which is joint between the University of California at San Diego and M.I.T., covers the energy range from around 10 kilovolts up to 10 MEV.

So there are a set of four highly integrated experiments, each covering, each dovetail into the other.

Now, the spacecraft to do this mission is shown in the next slide.

(Slide.)

DR. MCDONALD: Just to give you some scale, it is probably the largest scientific satellite that we have flown in this country. You see the solar panel, and here you see six of the NRL modules. The other three experiments and the seventh NRL module is mounted on the other face.

This spacecraft, the solar panels deploy out. This axis looks at the sun all of the time, and then you spin about that.

The basic spacecraft functions are contained in this bottom module, and the experiments in the top, this is shown better in the next view graph, which simply shows you both the location of the other three experiments now, the A-2 experiment on the background of spectroscopy, the A-3 experiment on source location, and the high energy experiment, as well as the SEM of the spacecraft equipment module, which is essentially the same type of module that will be used on HEAO-1, HEAO-2 and HEAO-B and HEAO-C.

(Slide.)

DR. MCDONALD: Now, the operation date has gone remarkably well. HEAO-1 was launched three and a half months ago. We have completed the survey of roughly half the celestial sphere. We have had some six pointing operations, ranging at a variety of different X-ray objects, and as I say, the operation itself of the spacecraft, of the ground operations, of the data flow has grown very, very well for a spacecraft that is this large and is this complex.

Each of the university centers and the various Government labs that are in involved get one orbit of quick-look data per day, sort of within 12 hours of the actual recording of that data. The scientists look at that data. The experiments themselves are very large. They can operate in a number of different modes. Depending on what they see within that quick-look data, they have the ability to reconfigure their experiment, so you can think of this as really a series of four observatories within observatories in order to optimize the data for those given observations when given celestial objects will be in that field of view.

In the future, we hope to augment the observers who are working on HEAO-1 with a guest observer program that will allow other workers access to data, as well as to provide a wider group of optical radio and other astronomers being associated with the program.

Without further ado, I will turn the next part of the program over to Dr. Herbert Friedman of the Naval Research Lab.

DR. FRIEDMAN: Our strategy for this presentation which was just agreed upon before we came up was for me to try to present some general background on X-ray astronomy and introduce some of the results and let my colleagues, the other experimenters, contribute in their own fashion the highlights of what they have accomplished in this first 100 days of operation.

So we will play it casually and see if we can give you the essence of what has been accomplished without burdening you with an enormous amount of detail.

As Frank McDonald has said, X-ray astronomy covers a very wide range of energy. The kinds of sources that produce X-rays are hot plasmas and hot can mean anything from 100,000 degrees up to billions of degrees; relativistic particles in the cosmic ray energy range which can interact with magnetic fields to produce synchrotron synchetron radiation; nuclear processes which go up into the million electron volt range and so on.

The various instruments on the spacecraft are I think a very good mix to do a survey of this entire spectral range. The principal objective of this mission is to cover the sky uniformly, give us a complete map as a new baseline for all future experiments in high energy astronomy.

The kinds of objects that now can be catalogued as principally X-ray sources include condensed objects of stellar mass, like neutron stars, black holes. I should even include white dwarfs, which are old familiar objects, but we will treat the white dwarfs also in the compact object category.

A white dwarf is about a million times as dense as the sun. We talk about densities in terms of tons per cubic inch. In the case of a neutron star, we talk about densities of a billion tons per cubic inch, and in the case of a black hole we talk about infinite densities and infinitessimal volumes.

In the galaxy, we find these objects primarily as the remnants of supernova explosions. When a massive star has gone through its normal evolution, it will finally explode and leave as a relic of the original star the highly compacted neutron star if the mass doesn't exceed between two and three solar masses.

If the compacted mass is greater than that, then the neutrons themselves crush and we get the black hole.

The way we see these objects primarily is by the enormous gravitational pull that they exert on the ambient medium near them or in a very much more exaggerated way, when they are paired with another star as a binary pair, in which case the tidal forces pull the great flow of gas from the normal star, which is usually a blue super giant, onto the compact object, the white dwarf, the neutron star or black hole.

The effect of this gravitational pull is truly enormous. The particles of gas which are drawn down towards the compact object impact with energies comparable to what one would get if one shot the particles out of a million volt accelerator, so they accumulate in very hot plasmas that remain then coupled to the region in which the impact takes place and generate the X-rays.

If the gas is impacting onto a neutron star which has a very strong magnetic field, the hot plasma will remain bound to the polar regions of the neutron star and will be dragged around with its spin so that the radiation comes out in a pulse form.

Many of the X-ray stars which are found in binaries show this pulse characteristic. They also show additional periodicities, such as the eclipse period. If one star moves behind the other and is blocked, the radiation is cut off if we are in the orbital plane, and additional fine structure, which depends on the gaseous regime, how gases flowing from one star to the other; when a gas stream gets in the way of the radiation, it will absorb it.

If a gas is accumulated in a disk which allows a slow funneling down towards the compact object, that disk can process and introduce various absorption features that have their distinct periodicities.

In the last year or two, a number of sources have been found which are identified with globular clusters. These are clusters at 100,000 to a million stars, and several of these show a bursting characteristic, although there are a substantially greater number that are not associated with globular clusters that show this bursting characteristic, but in essence, there is just an enormous morphology in these phenomena.

Bursts typically rise in a matter of a second, and can decay in a matter of 10 seconds or 10's of seconds. Some bursters are relatively, let's say, infrequent performers. They turn on and off with appreciable dead time intervals. Others keep exploding like a continuous stream of fire crackers; the rapid burster, which the M.I.T. group that Walter Lewin is associated with discovered with a SES-3 experiment, fires off several thousand times a day.

There are sources which show transient characteristics that resemble optical novae. They grow suddenly very bright and then decay over a matter of months. There are quite a number of these that have been discovered, as many as, I think, a couple dozen in one year, so they are a rather frequent kind of phenomenon.

There is X-ray emission that is associated with the structure of the interstellar medium. An old supernova will leave; well, a supernova produces a burst of material which spreads out into the interstellar medium and as this expanding bubble impacts the ambient gas, the shock front which is created heats up the gas and we get soft X-ray source.

Enough of these have taken place in the galaxy so that the whole galaxy has some of the characteristics as -- you can describe it as a bubble bath of these gaseous bubbles colliding with each other and leaving walls and tunnels of hot gas which radiates soft X-rays.

One of the experiments in this mission is particularly well designed to study those characteristics of the interstellar medium.

When we go outside the galaxy, we perhaps find the most spectacular kinds of events. There we truly get into the range of high energy. Astronomy in the last decade has produced a number of new discoveries, objects that have almost become household words, like radio galaxies, quasars, Seyfert galaxies, end galaxies, and most recently, the BL-Lacerta objects, which seem to show all of the violent characteristics of these active galactic nuclei to an extreme degree, like showing variations 10 times as fast as quasars and showing fine structure compactness that goes beyond what is found in the other very powerful galaxies.

These are certainly the most powerful sources in the universe. The power irradiated in several of these sources has now been found to reach 10^{46} ergs per second; if we translate that to kilowatts, that would be 10^{36} kilowatts, 10^{33} megawatts. Then if you think in terms of terrestrial sources where we think of 1,000 megawatts, it is an enormous power system. Here we are talking about something 10^{33} times as powerful.

We don't know what the mechanisms are that create the power in these sources. One can think of supernovae, like the Crab nebula ~~crab nebulla~~ going off in unison, a million supernovae, let's say, one per day, that sort of thing, for a total of a million or a hundred million such events.

We have talked about chain reacting supernovae. We talk about giant stars of million or hundred million solar masses, spinaurs (?), giant pulsars, black holes and so on, and all of this is still in the highly speculative stage, and what we hope for from the kinds of experiments we are doing now in this HEAO series is to acquire more detailed information about these phenomena to the extent that we will be able to narrow down the choice of models and hopefully come up with some definitive models.

Well, I think perhaps that is enough of general background. I would like to start by saying something about the A-1 experiment. To begin with, I want to repeat that all of the experiments on this spacecraft are big. They are an order of magnitude bigger than the kinds of instruments that have been flown before, and they gain their sensitivity by size. The ~~effect of~~ effective area that you present to the source increases the sensitivity in proportion to the square root of the area.

They also have much more sophisticated electronics so that they can see faster phenomena, and the very wide spectral range gives it a much more powerful diagnostic than any previous X-ray high energy spacecraft which has been devoted to a relatively narrow spectral range.

Now, we hope that we will geta complete map of the sky with sufficiently higher sensitivies so that we can expand the present catalog of sources by a substantial factor; let's say, five to 10. The present sum of all the catalogues of all the spacecraft gives us probably about 200 sources.

We would like to come out with 1,000 or perhaps 1,500 sources from this survey, and it will fill in the whole sky relatively uniformly, which no other spacecraft has done.

We would like to see the most distant and most powerful sources, the quasars, of which we now have only one which is really definite, 3C273, and it is the nearest and the brightest quasar. We would like to see a substantial sampling so that we can get a better idea of what their X-ray characteristics are and how they relate to their characteristics in other parts of the spectrum.

So let me show you some of the results then of the first 100 days and speculate about the meaning of some of them.

(Slide.)

DR. FRIEDMAN: This shows you six modules of the A-1 experiment, a very large survey experiment. There is another module on the other side which goes along with the other three experiments, and whereas typically in the past, the size of an X-ray detector was in the order of a square foot, each one of these modules is about six square feet.

As Frank McDonald explained, the spacecraft spins about its short axis, which points to the sun, and day by day, as the earth goes around the sun, the direction of pointing changes one degree a day; the detectors turn around that axis, and they sweep out great circles of the sky every 30 minutes, and the field of view is a slot field, so that in the basic survey emission, a star will pass through that field of view in about eight seconds, would come back to it 30 minutes later.

Day by day as the spacecraft turns, the width of the slot is sufficiently large so that on the ecliptic we can see sources for roughly four days. Of course, at the ecliptic pole, every pass goes through the pole and one gets an enormous amount of data for sources near the ecliptic pole.

(Slide.)

DR. FRIEDMAN: The next slide: Now, this is to give you a baseline for comparison. The last catalog produced by the Uhuru satellite, which is the first successful X-ray satellite, launched in 1970, contains this example of what typical scans look like. This is one scan through a source, and this is the result obtained when all of the available scans are added up.

I would call your attention to some very weak sources which are almost buried in the noise which are labeled six Uhuru counts and four Uhuru counts and four Uhuru counts. We use the Uhuru as a base for comparisons. The crab nebulla, for instance, produces 1,000 Uhuru counts, and so these are relatively weak sources.

Next slide, please.

(Slide.)

DR. FRIEDMAN: Now, this is an example of a source passing through the field of a HEAO-1 instrument, which is seven Uhuru counts, so that it compares in strength with those very weak sources I just showed you, and these are three energy ranges; very soft, medium range, and higher range, and you can see that the signal goes way off our plotting scale on the soft range. You get a very good signal in the intermediate range and a good signal on the high range.

That is one pass without any summation. With each sum, one improves the signal to noise ratio, and in effect, it goes with the square root of the total number of scans.

Next slide.

(Slide.)

DR. FRIEDMAN: Now, let's take a very weak source and one of these very spectacular new objects in the sky.

Markarian-501 is a BL-Lacerta object. It is one of these quasar-like objects which shows all the quasar properties to an exaggerated degree, and it is about as far away as the one quasar we have observed, the 3C273, in the past. Here you see one scan which is just slightly suggestive. Summing several scans, it begins to show the source. After one day we see it quite clearly and after four days, we have a very good signal, something like a 15 sigma.

So we are able to see this kind of a source now quite reliably, and we have a good expectation that we will have a catalogue of quasars and BL-Lacerta objects.

Next slide.

(Slide.)

DR. FRIEDMAN: This is part of a trace of one great-circle sweep of the sky, and all of these bumps are real sources. We have a number of criteria for establishing whether the source is truly there. We look at it in different energy ranges. We look at it in individual scans, one-day scans, two-day scans and so on, and we can estimate from this sort of a survey that we will achieve the goal of about 1,000 or more sources total.

Next slide, please.

(Slide.)

DR. FRIEDMAN: I want to point out two sources here, this one and this one. The arrowbox (?) for those sources include two quasars; one of them is at a red shift of about .6, and the other about .8, so we are now seeing sources more than half-way to the edge of the universe in their X-ray emission.

Next slide.

(Slide.)

DR. FRIEDMAN: Let's move on to the next one.

(Slide.)

DR. FRIEDMAN: There are two black hole candidates of stellar mass that we want to study very intensively. One is Cygnus X-1, which has been known for a long time, and the other is a source in Circinus, Circinus X-1.

The characteristic of a black hole source we believe is a very bursty character to the X-ray emission. The black hole accretes gas from a companion star. The gas enters into orbit around the black hole; it slowly spirals in and forms what we call an accretion disk.

The conditions in that disk are very turbulent and should produce a very spasmodic kind of X-ray emission. In theory, one can model the accretion disk and calculate what its speed of rotation about the black hole is in terms of the total mass involved, the total brightness of the emission and so on.

Now, these are examples of individual passes across the Circinus source, and we see the bursty nature in a very striking kind of burst or flare, one might call it; an extremely sharp rise and extremely sharp drop, which is rather unusual, in spite of all of the variety of bursting phenomena that have already been found.

(Slide.)

DR. FRIEDMAN: In the next slide, this is very preliminary information. It is another pass, and this doesn't happen every pass. It comes and it goes, but when we do a thorough analysis of all of these peaks, we find that they are almost perfectly periodic, at least better than one percent with a period of about 2.5 seconds, and when we analyze it still more closely, we find that there are two periods very close together which seem to be beating against each other.

Well, this is very preliminary and I mention it only because it is so interesting. If this is true, then we are not dealing with a rigid rotater. We are dealing with something which has some twist to it, and this is more in line with the thinking of an accretion disk circulating around a black hole, as material slowly spirals into the black hole.

Next slide.

(Slide.)

DR. FRIEDMAN: Again, just to show the power of these big detectors, we can -- in the past, when we have looked at pulsars, it has been necessary to add several cycles, generally 10's or 100's or 1000's of cycles of the pulsar in order to get a light period of the pulsar. With this instrument, one can look at successive pulses. In this case, Hercules X-1 has a pulse rate of about 1.2 seconds, and these upper curves show the summations of the pulses in each one of these strips.

The interesting thing is that there are obviously marked variations from pulse to pulse, and so we now have a basis for modeling on a much more detailed scale than we have before.

I think these are some of the most interesting demonstrations of the potential of the large survey instrument on HEAO-A-1, and I would like to give my other colleagues a chance to add some of their most interesting results to this story.

The next group will be the A-2 group. Gordon, are you going to do it?

DR. GARMIRE: I know your time is limited, and I would like to just call attention to one interesting result that we have. We have been studying the sort of low energy background from the galaxy, but one of my graduate students, Franz Cordova, has been looking at cataclysmic variable stars. These are stars which go along

she?

for a few months at a time and then suddenly flare up, and have been very curious as to whether these objects produce X-rays or not, and she is working on a thesis studying these kinds of stars.

She came in on about the 19th of October and she said a star of U-Geminorum, which has been known for some time to be in this class of objects, was suddenly flaring, and the HEAO spacecraft was just passing over this region, so I think the first viewgraph here shows the kinds of things.

(Slide.)

DR. GARMIRE: But anyway, she came in excited. She had been following these things for some time, and just to get one to flare when HEAO was passing by is very unlikely, so she was very excited and said we should look at the data that night to be sure that this one day of quick look data might have the source in it.

Just as Dr. Friedman showed you, there is a scan of the sky. Each one of these little bins is an intensity as we scan across. Here is the earth, which is faint for our detectors when we look at the dark earth, and then we come up on the sky again. Right here was where the source was supposed to be, so there was a certain amount of disappointment not to see anything striking in the data.

Then I had to fly to Washington for a meeting at NRL, in fact, for a day, so I didn't know what happened. On the way back evidently they were trying frantically to get a hold of me because that day's data, lo and behold, the next slide showed this very remarkable result.

(Slide.)

DR. GARMIRE: Here is the object, and it is practically driving our detectors into saturation, so we were really very excited to see that this kind of object, this cataclysmic variable star suddenly can go along, and there is a little bit of time delay evidently between the optical outburst and the X-ray burst, but here, in fact, you see it coming in very loud and clear.

So her efforts have been rewarded in getting a very nice piece of data for her thesis to work on.

DR. BRADT: I have a couple of brief results that we would like to tell you about. First of all, there is a photograph of one of these results and a very brief handout in the back table there on the A-3 experiment.

The thrust, as you heard, is to find out where these sources are with good precision, so as the spacecraft scans around, in Herb's previous experiment, detects these sources, and the A-2 experiment studies our? ~~studies are~~ spectra (?) both experiments do. The A-3 experiment can nail the position with great precision, like 30 arc seconds, or I see we are getting down to numbers like 10 arc seconds, keeping in mind that the moon is like 30 arc minutes, which is a factor a couple hundreds times smaller than the size of the moon.

We have succeeded in getting the position of two different objects, one of them which is a nova, and what happened there was that as the HEAO was scanning along the people looked in their data and here is this, just like you just saw, only a different one, a source that had become very bright. It turns out a satellite group had seen it earlier. The HEAO people saw it and on the 8th of September, within two days; thanks to the NRL experiment and the A-3 work, a precise enough position was had to send to the Anglo-? Angle Australian telescope, and the game here obviously is to find these things in the optical and the radial, so you can study the physics of them in all three wavelength domains, the X-ray, the radial, the optical.

What happened here in the first slide is that in the picture, it was taken on the night of the 10th with a four-meter telescope on the Angle Australian telescope. On this piece of the sky, the experiments defined this region. The X-ray source is somewhere in here, and this is like 20 arc seconds across.

There was a star right there some 16th magnitude which was not on the earlier Palomar sky survey, or if it was, it was very, very faint, that little smudge there. This is simply by comparing the two pictures. The optical astronomers immediately with the HEAO results are able to say, "Aha, there is the star."

Why is this important? It is important because you have heard about stars dumping material onto neutron stars or onto black holes, and the question is: What are the details of what is happening?

Some of this dumping seems to start very fast and build up, as Herb said, and stay there for some weeks. What is going on? Where is the matter coming from? How is it going? All of this is important to understand.

There are two things which we think can happen. One is that there is a wind flowing out from one star and dumping onto the neutron star; and another one is that the star sort of expands and dumps lots of material on.

This kind of star, we don't understand how it can do that very well because it is a low mass star. It is not a typical X-ray source as we used to think of them, and so it is giving the theorists quite a bit of a problem to understand these objects, and the fact that HEAO got onto it, got the position fast enough so the optical astronomers could get it while it was still bright -- they can't study it when it is not there -- means that I think

HEAO really helped the progress; it will help the theoretical progress on these projects.

The other result is on the next view graph.

(Slide.)

DR. BRADT: A similar thing, the HEAO experiment said, "Where is a given source?" The source we are talking about here is the rapid burster you have heard about, which goes off, "Bang, bang," the firecrackers, with time constants as short as a minute. Is it less, Walter? ? who he?

SPEAKER: Five seconds. Dr. Walter Lewin, M.I.T.

DR. BRADT: As short as five seconds, the burst times, and Liller at Harvard found the core of a globular cluster, studied by other people, the different group of infrared astronomers who confirmed this was a core of a globular cluster, but prior to this, the position was sort of as big as twice as big as this screen, the position of the X-ray source, and our HEAO experiment managed to nail down where a couple of those bursts came from. It came from somewhere in here, which we believe confirms that this globular cluster core, Liller-1, is indeed the location of that rapid burster.

The physics of the rapid burster has been a subject of a lot of discussion. Dr. Lewin is here, if you want to talk later about that or have questions to discuss it.

One of the main things is that the rapid burster is so unique that nailing down where it comes from clearly has to help constrain the models.

Thank you.

I am sorry. It is an unfortunate problem that we called this experiment the scanning modulation collimator because there have been rotating modulation collimators. It is a problem.

DR. PETERSON: I just wanted to say a few words about one of the phenomenal revolts which we have verified essentially on the HEAO by looking at the higher energy portion, the more energetic, the more penetrating portion of the X-ray spectrum.

About 1973 there was discovered a very interesting phenomenon, an usual and unexpected phenomenon which takes place in the gamma ray and X-ray sky. What you think about the gamma ray sky is not quite the way you think about the optical sky, where you look up and you see a bunch of dots which are stars, and a broad band, which is the Milky Way, but in the X-ray and the gamma ray region, the whole sky is bright, and the individual sources that have been talked about so far are like pinpoints of light on that sky.

Well, in the gamma ray sky, in addition to being bright, so if you look at it with gamma ray eyes you would see light all the time, you also can see pinpoints of light here and there. You can also suddenly see flashes of gamma rays, which are sort of like a flashbulb went off in some part of the sky, and these you don't understand the nature of this particular gamma ray burst phenomena.

As I indicated, this was discovered way back in 1973, and the typical kind of phenomena that are associated with these bursts are indicated in this particular event here, which was discovered and measured on October 20th on the HEAO satellite.

What we plot here is essentially the intensity of the gamma rays versus the time, and each one of these little dots is a second, so what we see is a very vast bursty structure which has characteristics times on the order of a tenth of a second or a second and a duration on the order of 10 or 15 seconds.

When you work out the total energy, the total luminosity that is associated with that particular phenomena, it is sort of like the sun released all its energy in gamma rays (and? in perhaps released 10,000 times its ordinary energy that is put out in gamma rays and did it over a few seconds.

All I wanted to do was show this kind of phenomena takes place. At the present time we have not been able to associate this phenomena with any of the known kinds of objects which appear in the sky; that is, we don't even know whether they are associated with the stars in our galaxy or whether they are associated with distant stars fixed to galactic objects at the present time.

One of the things we hoped to do on the HEAO is to measure enough of these bursts and if we measure these bursts on the HEAO and in conjunction with other satellites which are scattered throughout the solar system which NASA has launched, we can essentially do a triangulation and determine hopefully at least whether or not these sources are galactic, local, relatively or extra-galactic exceedingly distant, and perhaps even obtain locations sufficiently accurate so that the kind of work which Hale Bradt just showed could be accomplished.

That is, we could look at a star chart and try to identify these phenomena with specific stars or known objects in the sky.

Thank you.

MR. PANAGAKOS: Thank you. If the participants will gather at the table on the stage, we will be ready for questions in a moment.

We also have some people in the audience who can answer questions on the conduct of the mission, like Bland Norris, Director of the Astrophysics Program, who is in the back there someplace; and the Deputy Director, Dr. Richard Henry; Dick Halpern, the HEAO Program Manager; We have Dr. Walter Lewin down front from M.I.T, who is also a P.I. on the hard X-ray and low energy gamma ray experiment, and Dr. Fred Spear is here, who is the HEAO project manager from Marshall, and Dr. Herbert Gursky, from the Smithsonian Center for Astrophysics, who is a P.I. with Dr. Bradt on the scanning modulation collimator experiment.

I think we are ready for questions now. If you could identify yourself and your affiliation, it would be helpful for transcript purposes.

Walter?

MR. SULLIVAN: Sullivan, New York Times. For Dr. Peterson: These are the bursts Vela has been seeing?

DR. PETERSON: Yes, that is correct.

MR. SULLIVAN: Would the Vela data be of any help in triangulation? Have you done some triangulation?

DR. PETERSON: All of the information that is known so far has been obtained from the Vela data. This particular burst was also observed by the Vela satellite, but in particular was observed by an instrument on the heliosatellite, which is located something like an earth-sun distance away from the earth at the present time. That is the one that we will perform the primary basis for the triangulation, which we hope to obtain with this event.

MR. SULLIVAN: Could I ask Dr. Friedman about the Circinus X-1 bursts? With Cyg X-1, the burst trains never follow the same rhythm. The rhythm keeps changing, and that is one of the parts of the black hole model for that. Would Circinus X-1 qualify in this way, or is that periodicity rather constant?

DR. FRIEDMAN: The periodicity is relatively constant. We don't know yet whether it has a precision of a pulsar, which would clearly rule out the black hole, but what is suggested is that there are two periodicities in there which implies that there are different hot spots radiating at the same time at slightly different radii, and essentially requiring that the object is not rigid, but does show differential rotation.

That is a hand-waving sort of extreme, but it is the kind of thing we are looking for as an answer to the black hole question.

DR. BRADT: I would like to add, if I may, that we have done extensive studies with the SES satellite with much less area but longer term observations, looking for the steady kind of period that would rule out the black hole model, and it is just not there.

I am not addressing myself to the short-term kind of things that Herb just addressed.

MR. PANAGAKOS: Craig?

MR. COUVALT: Craig Couvalt, Aviation Week.

One of you mentioned your capability to reconfigure on the basis of your quick look data, and I believe you might have given an example. Can you go down the line and individually cite some examples on how you have reconfigured on the basis of quick look?

DR. GARMIRE: Well, for example, on our experiment, the A-2 experiment, we were looking at a source, the A. M. Hercules binary star system, which contains the white dwarf with 100,000,000 ~~Gouss~~ Gauss magnetic field at its pole, and it is a very soft source we have found, so that we turned our high voltage up on the basis of that so we could get a better response at the low energy.

That is one of the kinds of configurations. Also, we can change the time resolution of the instrument, but in this particular case, we don't believe that it is a very rapid time bursting source, so we didn't change in that particular mode.

DR. BRADT: Hale Bradt. The X-rays are so variable that this kind of response is very important.

DR. PETERSON: Peterson from U.C.S.D. The sort of things that we can do are mostly associated with being able to trade off, we call it, to determine whether or not one has a lot of spectral resolution, can distinguish the different kinds of X-rays and gamma rays, and different energies versus time resolution. We use this continually as we go through the different scanning modes of the or for pointing at a source; for example, Cygnus X-1.

MR. SEHLSTADT: Al Sehlstadt, Baltimore Sun. I understood Dr. Friedman to say we are now seeing more than halfway to the edge of the universe. I didn't understand if you were referring to the instruments aboard this satellite that were making that possible or are you referring to the broad spectrum of X-ray astronomy as a whole?

In either case, could I ask you how far is halfway to the edge of the universe?

(Laughter.)

DR. FRIEDMAN: On the order of 8,000,000,000 light-years, and I was referring specifically to two weak sources appearing in that one scan; the error boxes for those sources include two quasars, and we know their red shifts from optical studies. But the impressive thing is that this generation of X-ray instruments already can reach out to such enormous distances.

SPEAKER: The two sources you saw at this distance of 8,000,000,000 light-years were quasars, did you say?

DR. FRIEDMAN: Yes.

MR. PANAGAKOS: Tom?

MR. O'~~TOOLE~~ ~~(Post)~~: ~~Herb~~, what more proof do you need on Circinus? What kind of proof will you try to get in the near future to nail down further, and when will you go to Cygnus X-1?

DR. FRIEDMAN: We have a lot of data on Circinus, and we want to analyze it to the point where we have enough precision to say that there is more than one periodicity there or to say how precise or how variable whatever periodicity exists is.

In the case of Cygnus X-1, we have just very recently passed through that region, and we do have an enormous amount of data on it, but we haven't gotten into the analysis yet.

We get our production tapes roughly six weeks after the spacecraft has looked at a source, so we are still waiting to receive those data.

The very suggestive characteristic of the Circinus data is that these trains of pulses are transient. They appear; they disappear; come back again, and it is the sort of thing that theorists have modeled for the accretion disk around a black hole. You have gases circulating; it is hot; it is producing very noisy radiation, and then a hot spot appears and it gives a specially intense signal, and it circulates for a certain number of orbits of this disk before it disappears.

SPEAKER: Not at two and a half seconds.

DR. FRIEDMAN: Two and a half seconds would create quite a problem for the existing models, yes.

But I think everything in astronomy is a little wild, and factors of 10 at first seem disconcerting and then are accepted.

SPEAKER: Have you ruled out millisecond events?

DR. FRIEDMAN: We have not seen periodicities in a millisecond range because we haven't analyzed the data yet. To get into the millisecond range, we have to use what is called the high byte rate mode, where the instrument is put into configuration to record very high time resolution, but it is a little bit like Russian roulette. The satellite has to have the source in its field of view when the instrument is in that condition to look at it.

We do have that kind of data on Circinus, but we haven't gotten to analyze it yet.

DR. BRADT: I would like to add a comment on Circinus. One of the things that got us where we are at Cyg X-1 was the optical identification and then the study by the optical astronomers would show that the secondary star was more massive than it could reasonably be expected from a known type of star and hence a black hole.

One of the most important developments, other very important development in Circinus lately is that the British have found that star. It is a radio-emitter, but it is very, very faint, it is the 19th magnitude; it is going to be a very difficult job to study the spectral lines, but that is one way the show ought to go. I don't know if the optical astronomers can pull it off, because it is very tough.

MR. PANAGAKOS: Howard, do you have a question?

MR. BENEDICT (AP): Yes, for Dr. Friedman. You said you would like to identify 1,000 or more new X-ray sources with the satellite. How many have you identified so far with the satellite?

DR. FRIEDMAN: The Uhuru, which is the early one launched in 1970, has contributed most of the known sources, the order of 160 to 180, and then various other satellites that have been flown in the interim have added to that catalogue, and I think 200 is a rough number of what we had to start with at the beginning of the HEAO mission.

MR. PANAGAKOS: Al, you had another question?

SPEAKER: He was asking you how many new ones you have seen so far with HEAO.

DR. FRIEDMAN: Well, we have only looked at a small piece of the sky, and if we multiply that by the full sky factor, we will come out with 800 to 1,000 sources, if that is a typical piece of sky. I think with more time and more effort in the data analysis, that number can be increased substantially.

We have about 120 sources. Let me withdraw that.

SPEAKER: It seemed to me from several presentations that there was references to an awful lot of bursting going on out there, and I was wondering if this was something that you expected to receive this kind of information through X-ray astronomy. In other words, is this characteristic of X-ray astronomy or is it something that is a bit of a surprise to you?

DR. FRIEDMAN: I think it is a fantastic surprise. You know, traditional astronomy done by exposing photographic plates, they integrate over a long time. This kind of phenomenon would never be detectable, and in X-ray astronomy with its high sensitivity and high time resolution, we find this whole world a fast explosive bursty phenomenon.

MR. PANAGAKOS: Behind you, Les?

SPEAKER: What is the operation lifetime of the spacecraft?

DR. FRIEDMAN: On the order of 15 to 18 months, and that will be limited by the amount of hydrazine fuel, in all probability, available for maintaining the spin and maintaining the orientation towards the sun.

MR. PANAGAKOS: Al Rossiter, down front.

MR. ROSSITER (UPI): Just to follow up on Howard's question before, can we say now, Dr. Friedman, how many new sources you have seen so far in the small sector of the sky you have looked at?

DR. FRIEDMAN: Kempt Wood, can you give me that number?

DR. WOOD: There were 15 new ones in that small section of the sky and it reprsented about one-twentieth of the total sky.

MR. PANAGAKOS: Could you identify yourself again please for the record?

DR. WOOD: Kempt Wood, Naval Research Laboratory.

MR. PANAGAKOS: Al, another one?

MR. ROSSITER: One brief follow-up. Could you say anything about these 15 other than that they are X-ray sources?

DR. FRIEDMAN: The identifications for some of them seem very suggestive, and most of them contain clusters of galaxies. This is already well known that clusters of galaxies contain very hot gas, 100,000,000 degree gas, which radiates X-rays, and they form a class of the most powerful X-ray sources in the universe. We see them to great distances.

So I would say the largest number of these sources seem to coincide with more distant clusters of galaxies.

MR. PANAGAKOS: If there are no more questions -- oh, one more. This will be the last question, please.

SPEAKER: What was used to calibrate the spacecraft's instruments? What source was used?

DR. MCDONALD: I am sorry.

MR. PANAGAKOS: What was the source used to calibrate the spacecraft's instruments?

DR. MCDONALD: Each experiment used different calibration facilities. I think the high energy was calibrated mainly with radioactive sources. The X-ray experiments were calibrated, the A-2 experiment, with the large calibration facility at Goddard, and then the A-4 and the A-3 experiment was calibrated by a source at a large distance and was to check the alignment of the modulation collimator, and this was checked two or three times during the integration and during the test phase two.

SPEAKER: Is there still an option to recalibrate them in orbit?

DR. PETERSON: In general, there are radiation sources on many of the experiments that allow them to keep checking the calibration. There are light lamps on the A-3 experiment, I believe, so they can check that alignment. The best performance in many cases is checked, how well you see a very strong source, for example, and then you measure the data. The crab nebulla continues to be a good calibration source.

MR. PANAGAKOS: This concludes our briefing for the day, and thank you very much.

(Whereupon, at 1:25 p.m., November 29, 1977, the press conference was adjourned.)